PRELIMINARY PUBLIC HEALTH ASSESSMENT

BIG RIVER MINE TAILINGS DESLOGE
(a/k/a ST. JOE MINERALS)
DESLOGE, ST. FRANCOIS COUNTY, MISSOURI
CERCLIS NO. MOD981126899

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Prepared by

Missouri Department of Health
Bureau of Environmental Epidemiology
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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GUIDE TO ACRONYMS AND ABBREVIATIONS

The data tables and text include the following acronyms and abbreviations. This table is provided as an easy reference to their meaning:

ATSDR	=	Agency for Toxic Substance and Disease Registry
CREG	=	Cancer Risk Evaluation Guide: $1x10^{-6}$ excess cancer risk (ATSDR)
D	=	Dissolved
DOH	=	Missouri Department of Health
EMEG	=	Environmental Media Evaluation Guide (ATSDR)
EPA	=	Environmental Protection Agency
HARP	=	Health Activities Recommendation Panel (ATSDR)
LTHA	=	Drinking Water Lifetime Health Advisory (EPA)
MCL	=	Maximum Contaminant Level (EPA)
MCLG	=	Maximum Contaminant Level Goal (EPA)
MDESE	=	Missouri Department of Elementary and Secondary Education
MDOC	=	Missouri Department of Conservation
MDNR	=	Missouri Department of Natural Resources
mean	=	average of all samples
MSCDC	=	Missouri State Census Data Center
NA	=	Not Analyzed
ND	=	Not Detected
PHAP	=	public health action plan
PMCL	=	Proposed Maximum Contaminant Level (EPA)
ppb	=	parts per billion
ppm	=	parts per million
PRP	=	Potentially Responsible Party
region	=	includes the area of major tailings piles
RfD	=	Reference Dose (EPA)
RfD-C	=	Media Concentration calculated from the RfD (ATSDR)
RMEG	=	Reference Dose Media Evaluation Guide
site	=	Big River Mine Tailings/St. Joe Minerals site
T	=	Total
TRI	=	Toxic Release Inventory (EPA)
USGS	=	United States Geological Survey
XPF	=	X-Ray Fluorometry

-	=	Not Available

Other Symbols

μg/dL	=	micro grams per deciliter
μg/kg	=	micro grams per kilogram
μg/L	=	micro grams per liter
$\mu g/m^3$	=	micro grams per cubic meter

An Important Note to Readers: This document is the result of only one of the many public health assessment activities that are being conducted at the Big River/St. Joe Minerals, Desloge, site. This document was initiated in 1992/1993 and was not submitted for public comment until March 1994. The release of the final document was further delayed. Many activities have occurred at the site and in the surrounding communities since the initiation of this document. For that reason, information on those activities will be provided in future documents, one of which will be initiated in late 1996.

Summary

The Big River Mine Tailings/St. Joe Minerals Site was formerly a lead mining and milling operation located in the Old Lead Belt of Missouri. It operated from 1929 to 1958. Milling operations at what is now known as the Desloge site included the crushing of limestone and lead ore, removal of the ore, and disposal of the sand or smaller-sized particles in a large pile within a horseshoe bend of the Big River. The crushed limestone, called tailings, was deposited to a maximum depth of 100 feet. The tailings have been found to contain low levels of metal contamination including arsenic, lead, cadmium, and zinc. Tailings have been and are being eroded from the site by wind and water into the Big River and surrounding area. A major collapse of a portion of the pile occurred in mid-1977, sending approximately 50,000 cubic yards into the Big River. Further, there are other large tailings piles located in nearby residential areas with similar wind and water erosion problems.

Sampling has found elevated metal contamination in the Big River's sediment, surface water, and biota, including fish. Metal contamination has also been found in residential yards, in household vacuum cleaner dust, and intermittently in ambient air.

Considering the wide-spread contamination and long-term exposure, the site is considered a public health hazard. Various completed exposure pathways exist. Exposure to children is of most concern. It is not known if the long-term, low-level exposure to lead is causing any public health problems. Community concern about site-related lead exposure was initially low, though some local residents have been concerned about the health impact and annoyance of the dust blowing from the tailings piles on dry, windy days. Community concern about exposure has increased and is being addressed through work with a Citizens Advisory Group and through other community involvement activities.

Stabilization of the site's tailings piles was recommended to prevent further erosion. The problem of eroding tailings is regional, so stabilizing the other piles is recommended as well. Some stabilization work is complete at the Leadwood site and has begun at the Big River site. A permanent solution to these problems is recommended. A health study was also recommended to determine what health effects that long-term, low-level exposure to metal contaminated mining waste has had on the public. That study is underway.

The data and information developed in the Big River Mine Tailings/St. Joe Minerals Preliminary Public Health Assessment have been evaluated for appropriate follow-up health actions. The Agency for Toxic Substances and Disease Registry's (ATSDR) Health Activities Recommendation Panel (HARP) was in agreement with the findings of the health assessor. People are being exposed to contaminants from the site at

levels that can cause illness. Exposure to contaminants is caused from past regional mining practices and not confined only to site contaminants. An education program is needed (and is currently planned) to inform the local community and health professionals about how exposures can be reduced, as well as about health effects that might result from exposure. The health outcome data evaluation indicates there is an increased lung cancer rate among people living in the region near the mine tailings. A health consultation would help identify the exposed population. Once the exposed population is identified, a cluster investigation is indicated to determine if the increased cancer rate is associated with exposure to contaminants from the site and others like it, or if the excess of cancers is a result of other factors, such as smoking, or a combination of several factors. ATSDR will reevaluate this site for additional follow-up public health actions if new data become available which indicate a need to do so.

Recommendations are made in this public health assessment that, if implemented, would prevent or diminish exposures at the site. A plan to conduct these actions has been developed. According to the plan, the Missouri Department of Health (DOH) and ATSDR will consider the feasibility and resources available to implement the public health actions identified by HARP; DOH and ATSDR will coordinate with the appropriate environmental agencies to develop plans to implement other recommendations contained in the preliminary public health assessment. New environmental, toxicological, or health outcome data, or the results of implementing proposed actions and plans, may result in the need for additional actions at the site.

An Engineering Evaluation/Cost Analysis has been completed on the site and stabilization efforts on the tailings have begun. Negotiation of a Remedial Investigation of the site was scheduled for spring 1996. Information on that will be included in update documents on site activities. A human exposure study is in process to determine the effect the environment, site, and tailings in the area has had on the blood lead levels of children in the area.

BACKGROUND

The Missouri Department of Health (DOH), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), will evaluate the public health significance of the Big River Mine Tailings/St. Joe Minerals site. More specifically, DOH/ATSDR will determine whether health effects are possible, and will recommend actions to reduce or prevent possible health effects. ATSDR, located in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services, and is authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (commonly known as CERCLA) to conduct public health assessments at National Priorities List (NPL) hazardous waste sites. DOH, under a cooperative agreement with ATSDR, is responsible for conducting the public health assessment. This public health assessment is the first involvement that ATSDR has had with the Big River Mine Tailings/St. Joe Minerals site. The Big River Mine Tailings/St. Joe Minerals Site was proposed by the Environmental Protection Agency (EPA) for placement on the NPL in February 1992, and its listing was finalized in October 1992.

A. Site Description and History

The Big River Mine Tailings/St. Joe Minerals Site (considered "the site" in the text) is approximately one-half mile northwest of the city of Desloge, St. Francois County, Missouri. It consists of approximately 600 acres of mine tailings that range in depth from zero to more than 100 feet deep, with an average depth of approximately 50 feet. The mine tailings are the result of 30 years (1929 to 1958) of dumping lead mining waste from a mine/mill operation once located on what is now the southern edge of the site. The majority of the site is situated within a horseshoe-shaped bend of the Big River that flows around it on the east, north, and west sides. Residential areas and the city of Desloge are adjacent to the site on the south and southeast (See Figure 1).

The site is located in an area of southeast Missouri known as the Old Lead Belt. The area is approximately 70

miles south of St. Louis, Missouri. Mined for more than 100 years, the area was the nation's largest producer of lead from 1907 to 1953. Lead was first discovered around 1700 in southeastern Missouri. Before the mid-1860s, lead mining consisted of individual, shallow workings scattered throughout the area. In 1869, diamond-bit core exploratory drilling revealed lead deposits underlying Bonne Terre, Desloge, Flat River, Leadwood, and Elvins. Mines were established at these sites and continued in the area until the last mine closed in October 1972. Prominent reminders of the area's long mining history remain today with six major tailings piles or ponds, several smaller tailings areas, and numerous closed mines scattered throughout the 110-square-mile Old Lead Belt area (USGS 1988). A total of approximately 250 million tons of tailings were produced in the Old Lead Belt, with the majority stored in the six major tailings piles (considered the "region" in the text). During the productive life of the Old Lead Belt, two different methods were used to separate minerals from the limestone. The early method used density separation by jigging to separate the ore. Later, a froth flotation method that separated the ore by use of chemical collectors was used. The chemical method resulted in a finer particulate waste rock material. After processing, the tailings were transported to a disposal location by a slurry pipeline in about a 50 percent water mixture. The material was dumped directly on the land surface or used to fill valleys. The water drained away, leaving the tailings. Waste rock from the early method is called chat, while waste rock from the later method is referred to as tailings (Wixson et al. 1983). Because the material varies from powder to large sand-sized particles, this health assessment will refer to all the material as tailings.

To the south of the site is the city of Desloge. Desloge is one of several small towns separated only by political boundaries. Some of these political boundaries no longer exist; the cities of Flat River, Rivermines, Elvins, and Ester joined together on January 1, 1994, to become Park Hills. Three additional tailings piles, the National, Federal, and Elvins piles are located in the vicinity of these small towns. A fifth tailings pile, the Bonne Terre pile, is approximately two miles north of the site next to the city of Bonne Terre. Approximately two miles to the west is the sixth tailings pile, the Leadwood pile, located next to the city of Leadwood. See Figure 2 for the location of the cities in relation to the various tailings piles.

The Big River Mine Tailings/St. Joe Minerals site is listed on the NPL and is the focus of this health assessment. The site is different from the other piles in that the Big River flows around it on three sides, it is elevated above the river, and it is being undercut by the river, which allows tailings to directly enter the river. Wind and water erosion are also moving the tailings into the river. None of the other tailings piles are situated directly on the Big River, although the majority of the drainage of the piles enters the Big River by various tributaries.

St. Joe Minerals Corporation (formerly St. Joe Lead Co.) owned the 600-acre site until 1972 when it donated 502 acres of the site to St. Francois County. After acquiring the land, St. Francois County leased the property to the St. Francois County Environmental Corporation (SFCEC). In 1973, the non-profit SFCEC organization established a sanitary landfill on approximately 60 acres in the southwest section of the site. The landfill, regulated by the Missouri Department of Natural Resources (MDNR), accepts typical residential refuse and debris. Mine tailings are used for daily cover. When a section is full, soil cover is added and then seeded with grass. Before the present engineering firm took over management of the landfill in about 1985, MDNR records reveal that the landfill operation had been cited numerous times for violations. Approximately 100 acres in the southeast corner of the site is still owned by St. Joe Minerals, who leases it to a company that uses the tailings to make asphalt, and to sell as agricultural lime (EPA 1991).

In late spring 1977 the area received heavy rainfall that caused a large portion of the tailings to become supersaturated and collapse into the Big River. An estimated 50,000 cubic yards of tailings washed into the river at that time (EPA 1991). Earlier in January 1977, MDNR had requested that EPA investigate the environmental damage that was being done to the Big River from the mine tailings. The investigation was conducted by the EPA Surveillance and Analysis team with sampling done in June and August 1977. No mention was made in the report of the major collapse of tailings that had occurred during the time period from request to sampling (EPA 1978a & b). The general finding of the report, based on aquatic population density and diversity, was that the Big River had been degraded. The river's degradation was mainly caused

by physical changes in the benthic zone (bottom zone where organisms attach or rest on the bottom or live in the sediments) of the river instead of chemical toxicity of the river water (EPA 1991).

In 1980, the Missouri Department of Conservation (MDOC) submitted evidence to DOH that fish (especially the sucker family) downstream of the site contained elevated levels of lead. The averages ranged from 0.4 to 0.7 ppm for edible fillets. A few individual fish exceeded 1.0 ppm, with a maximum of 1.28 ppm lead. Because of concern for increased human exposure to lead from the contaminated fish, MDOC and DOH issued a news release discouraging the consumption of suckers from the affected area of the river. This area was considered to be 50 miles long, from Leadwood downstream to Mammoth Access (MDOC 1980). DOH now updates this fish advisory annually and recommends that carp, redhorse, and suckers should not be eaten if taken from the Big River downstream from Desloge to where it enters the Meramec River (DOH 1993). Local fishermen generally know about by the warning.

The St. Joe Minerals Corporation began efforts in late 1981 to stabilize the pile, under a cooperative agreement with the State of Missouri. Since the major collapse of tailings in 1977, smaller gaps have appeared in different locations on the perimeter of the site.

In 1982, a report was released by the U.S. Fish and Wildlife Service on their study of the impact the tailings had made on the Big River. The report found elevated residues of lead, cadmium, and zinc in every biological form examined, including algae, rooted plants, crayfish, mussels, and fish (Schmitt and Finger 1982). For a summary of the 1982 report see Table 5 for water quality, Table 6 for sediment, and Table 9 for aquatic biota. In 1983, a report by the University of Missouri - Rolla was released that discussed the possible use of the mine tailings for agricultural lime. Measurements for lead, cadmium, and zinc were listed for five of the tailings piles in the area. A summary of those findings can be found in Table 3.

To provide short- and long-term stabilization and adequate site supervision, the Desloge Tailings Task Force was formed in 1985. The Task Force was organized by St. Joe Minerals and included representatives from St. Joe Minerals, the landfill authorities, and MDNR, as well as local officials. Efforts to control erosion of tailings from the site have included placement of snow fences, grass seeding of some areas, and planting Black Locust trees. None have proved entirely successful.

After landfill authorities requested a permit from MDNR to expand its operations into another 200 acres on the site, MDNR requested that monitoring wells be placed around the existing landfill. Six monitoring wells were installed around the landfill to determine if area groundwater contained significant quantities of landfill leachate.

In 1985/1986, DOH conducted a study of the adjoining residential community to determine the possible cause of an elevated lung cancer death rate. The investigation included possible environmental factors that could contribute to the excessive death rate. Samples were collected and analyzed for various environmental parameters, including radiation in the tailings and groundwater, radon in local homes, and metals in indoor dust (samples taken from home vacuum cleaners).

In 1988, EPA directed Ecology and Environment, Inc., Field Investigation Team (E&E/FIT) to do a preliminary assessment of the Big River Mine Tailings/St. Joe Minerals site. A site reconnaissance was conducted and site conditions were documented with photos. Ten samples, including a duplicate, were taken of tailings material on site. The report also mentioned that 35 mile-per-hour westerly winds were observed transporting tailings material off site (EPA 1988). In 1990, EPA again enlisted E&E/FIT to conduct a listing site inspection (LSI) of the site. This investigation was the most complete assessment of the site to date and included sampling of the tailings and soil, sediment and surface water, groundwater, and air. Soil was sampled on and off site, while sediment and surface water were sampled at points on the Big River and tributaries that drained different tailings piles. Air samples were taken for a six-day, 12-hour-per-day period on and off the site. All media measured had proper backgrounds for comparison to determine the effect the site was having on the local environment. Results of the investigation were released in a Final Report on October 30, 1991 (EPA 1991).

As a follow-up to the 1990 sampling, an additional study was conducted to determine if the site was having an effect on groundwater in the area. Forty-two private wells within a one-mile radius, and two on-site monitoring wells were sampled, mostly for metals. Of the original six on-site monitoring wells installed, three wells were dry and one had been unintentionally destroyed during erosion control activities (EPA 1991). To further understand the extent of contamination in the area, more samples were taken from the tailings piles, off-site soils, private drinking water wells, and a spring near the site. This included 405 soil samples that were screened for lead, 56 soil samples submitted to the EPA laboratory for confirmation analyses, and 35 water samples that included 12 private water wells with samples taken at the indoor tap and outside near the source. Those data are discussed in the *Environmental Contamination and Other Hazards* section of this document. By using this method of sampling, E&E sought to determine if any contamination encountered came from the groundwater or the household plumbing. The remainder of the water samples consisted of duplicates and a field blank for quality assurance, the landfill drinking water well, and the spring near the site (E&E 1993).

Tailings continued to be used throughout the area as fill material, as cover for dirt roads, to improve traction on local roads in winter, and by local residents for other purposes, although an EPA fact sheet discouraged these uses.

Action Implemented During Health Assessment Process

Action implemented during the health assessment process included an additional investigation by EPA of off-site surface soils near and influenced by the site. Soil samples were taken from a number of private yards south of the site at zero to one-inch depths, and were analyzed for lead, cadmium, zinc, and arsenic. This investigation's results are listed in the Off-Site Contamination section of this public health assessment.

Other sampling was conducted at the Federal tailings pile (St. Joe State Park) and included air monitoring conducted by MDNR during and after the St. Joe Grand Prix. The Grand Prix is a major racing event involving a large number of off-road vehicle (ORV) riders who gather at and use the Federal tailings pile for competition events and recreational riding. St. Joe State Park encompasses the Federal pile. Information on air sampling during the event became available when a risk assessment was completed by DOH on health risks for a recreational ORV rider, a seasonal worker, and an on-site resident. To determine the extent of exposure to MDNR park employees and nearby residents, blood samples were taken by the St. Francois County Health Department. DOH's laboratory analyzed the blood of 16 people for lead that may have had varying amounts of exposure to the Federal Tailings pile. Results of the blood sampling and other information are included in this document.

The landfill closed in 1994/1995 at the direction of MDNR. This was confirmed by an MDNR surveillance memorandum dated October 18, 1993, which stated that the landfill had ceased accepting waste and was in the early stages of constructing a transfer station to divert waste to another landfill. Areas where some former landfill operations were conducted have been regraded, covered, and revegetated (EPA comments, 1996).

DOH continues to release its annual fish advisory stating that sunfish, carp, redhorse and other sucker-type fish taken from the Big River in St. Francois and Jefferson Counties should not be eaten. The fish have been found to contain lead at levels that may be of health concern if consumed by people (DOH 1995).

The site changed ownership in the spring of 1994 from St. Joe Minerals to the Doe Run Company, which now has the responsibility of St. Joe Minerals interest in the Old Lead Belt.

EPA completed a Engineering Evaluation/Cost Analysis (EE/CA) for the Big River Mine Tailings Site in January 1994, released it for public comment from January to March 1994, and the document was signed on March 27, 1994. Short-term stabilization efforts took place in the spring of 1995 to prevent damage to critical areas from expected flood waters. Long-term stabilization efforts covered in the EE/CA are underway. Negotiations for a Remedial Investigation (RI) of the site were scheduled to start in 1996.

An exposure study was initiated and is in progress in the area. ATSDR is funding this exposure study to determine the blood lead levels in children from 6 months to six years old at Leadwood, Bonne Terre, and Park Hills. Blood lead levels in these children will be compared to children within the same strata living in an area where no exposure to past mining activities was expected. As part of the study, environmental samples (soil, indoor dust, water, and paint) are also being taken in the study and comparison area. In addition, a health education program is being planned to help people learn how to limit and prevent further exposures. Health care providers in the area have been supplied with information from the Centers for Disease Control and Prevention on treating patients with high lead exposure and with Case Studies developed by ATSDR to help them gather information from their patients and identify lead exposure cases.

On March 11, 1994, MDNR released a report on the results of a site investigation (SI) on the Federal Tailings pile. The purpose of the SI was to collect information sufficient to assess the threat posed to human health and the environment and to determine the need for additional investigation under the NPL Superfund law or other action.

B. Site Visit: April 29-30, and May 1, 1992

Arthur Busch and Ana Maria Murgueytio, representatives of the DOH cooperative agreement program with ATSDR, visited the Big River Mine Tailings/St. Joe Minerals Site and the surrounding areas on April 29-30, and May 1, 1992. On the first day, MDNR and DOH representatives investigated the National and Leadwood tailings piles. The National tailings pile is located in a residential/industrial area. This particular pile is high and steep, and little recreational activity was evident. A source of concern is that the base of the pile abuts backyards of homes where children live.

The Leadwood pile is more remotely located and was used heavily by recreational vehicles. At the time of the visit, a few off-road vehicles were present and stirred up a large dust plume as they drove on the hills of the tailings pile. Access was unrestricted at both piles.

The second day of the site visit was spent visiting the Big River Mine Tailings/St Joe Minerals site with the ATSDR Regional Representative and representatives from EPA, MDNR, U.S. Geological Survey (USGS), MDOC, St. Joe Minerals, the landfill operators and their engineering consultant. A landfill representative gave a tour of the site and pointed out all the areas that had been and continue to be a problem. There were areas where the tailings were being moved by wind and making direct contact with the river. Measures to eliminate this wind erosion were having little effect, as the sand-sized tailings were moving to cover the erosion-control fencing and trees. Areas where previous gullies had been were pointed out seemed to be causing no problem at the time of the visit. Characteristics of the tailings pile, including sharp drop-offs and bluffs over the river, were noted and recorded on film.

Vegetation that had been planted in the tailings was either dead, stressed, or showed little growth. There were only a few areas where vegetation seemed to thrive and prevent erosion. A portion of the river was observed, and tailings were common in the bottom material and as sand bars. A locking gate limited outside access at the entrance to the landfill by the landfill office. However, access can be gained easily from other locations around the site. With the daily landfill activity, recreational use of the site is limited during the week, but may occur when the landfill is closed. Recreational activity may increase with the final closing of the landfill.

We also saw a mining museum that is being created out of the old Federal mine and milling offices. After the site tour, the USGS representative, who is very familiar with the area, showed us public access points on the Big River. The group noticed that a number of fishermen and visitors were present at the upstream accesses. Fishing was reported to be poor. No fish were seen being caught or on stringers. Tailings in the streambed were very prevalent downstream of the site, but could also be found at locations upstream of the site. Tailings found upstream of the site could possibly be coming from the Leadwood tailings pile.

On the third day, the group visited with the St. Francois County Health Department administrator and the

head nurse. They were asked about the site and the other tailings piles. One comment was that on windy days, dust from the tailings piles was a real nuisance. The administrator reported that she heard little concern about the site as a cause of health problems.

Numerous subsequent trips have been made by the health assessment team to monitor activities and conditions at the site as well as on-going DOH interaction with the St. Francois County Health Department. Additionally, DOH and ATSDR participate in Citizen Advisory Group meetings and Mineral Area College (MAC) Environmental Information Roundtable meetings to keep informed and work with other agencies and community members to identify and resolve exposure issues.

C. Demographics, Land Use, and Natural Resources Use

Demographics

Located southeast of the site is the city of Desloge, which has a population of 4,150 according to 1990 census data (MSCDC 1991a). Desloge is one of several small towns separated only by political boundaries. Some of these political boundaries no longer exist because the cities of Flat River, Rivermines, Elvins, and Ester joined together on January 1, 1994, to become Park Hills. The combined population of cities southeast of the site and within three miles is 12,095. Approximately two miles north of the site is the city of Bonne Terre, with a population of 3,871. Approximately two miles west of the site is the city of Leadwood, with a population of 1,247. Leadwood and Bonne Terre have tailings piles adjoining them, while the group of cities has a tailings pile next to them or within a mile. The total population within approximately one mile of a tailings pile is 17,213. See Figure 2 for a diagram of tailings pile locations in relation to the cities.

The racial makeup of Desloge is 99.5 percent white. Seventeen percent of it's population was listed as being below the poverty level from 1989 data. The other cities mentioned have a similar socio-economic make-up (MSCDC 1991a).

Nine and a half percent of Desloge's population is six years of age or younger (MSCDC 1991a). The area is divided into three school districts; the North St. Francois County R-I School District has four schools with a Desloge address. They include a pre-school, two elementary schools, and a high school. Enrollment for the two elementary schools and the high school is 1,339. The number of children enrolled at the preschool was not available. The total number of students in the district is 2,786. Other school districts in the area are the Central R-III District of Flat River, with an enrollment of 1,951, and the West St. Francois R-IV of Leadwood, having an enrollment of 902 students. The total number of students in the three school districts is 5,639 (MDESE 1991-92).

South of the site, within one mile, is a day care center with approximately 30 to 40 children. Other day care centers and retirement homes are believed to be within a mile south and southeast of the site.

Until the landfill closed in 1994/1995, it employed four full-time employees. The asphalt contractor, located on the east end of the site, employed three full-time employees, with the possibility of two additional summer employees.

Land Use

The residential area of Desloge lies south and east of the site. Around the perimeter of the site in the other directions is the Big River. Across the river the land is pasture for livestock, cropland, or forest. North and west of the site, rural homes are located along the major roads, but large numbers of residences are not encountered until reaching the cities of Bonne Terre and Leadwood, approximately two miles from the site.

Natural Resource Use

Since the site is surrounded on three sides by the Big River, most of the natural resource use relates to the

river. Access to the river is available above and below the site. Use of river accesses above the site are for fishing and swimming. Heavy use of downstream accesses does not occur until approximately 37 miles downstream at Washington State Park. Activities on the river at this point include swimming, fishing, camping, and canoeing. No hunting occurs on the tailings piles, but may occur in the surrounding area. Use of the river becomes heavier farther downstream, with the St. Francois State Park offering similar recreational activities. An increase in canoeing starts at about this point because the river becomes more navigable. Off-road vehicles are driven for recreation over many of the tailings piles in the area.

Gigging of sucker-type fish is common on the Big River. According to a 1979-1980 MDOC survey of the use of facilities (i.e., state parks, accesses), giggers took more sucker species and carp (4.95 fish taken per hour) on the Big River than on the other two rivers surveyed. The 1980 advisory not to eat sucker-type fish was in full effect at the time of the survey (MDOC 1988).

Groundwater use in the area is by the local public water district and private well owners. The Flat River Water District supplies the cities of Flat River, Elvins, Desloge, Leadington, Ester, and Rivermines. The water district obtains it's water from two sources including a well at Desloge, and a flooded mine shaft in the town of Rivermines. (Active mining ceased in the area with the closing of the Federal mine in 1972.) The water district serves approximately 12,095 people. An unknown number of private wells exist outside the boundaries of the Flat River Water District. In a recent sampling by EPA, 42 private wells were found within one mile of the site (EPA 1991).

D. Health Outcome Data

The DOH's State Center for Health Statistics analyzes and provides consultations on health-related information collected from several sources (DOH 1992). The Center's Bureau of Health Data Analysis has vital statistical information (birth and death records), hospital discharge data, and the Multi-Source Birth Defect Registry. The Multi-Source Birth Defect Registry consists of birth outcome data from the following sources: birth, death, hospital discharge, Crippled Children's Services, and Neonatal Intensive Care Unit records.

Cancer mortality rates by age, sex, and cancer site are calculated to determine whether there is a significant difference between the area of concern and the rest of the state. Birth data include fetal deaths, low birth weight, and frequency of malformations. Data on the area of concern are then compared to the state rate.

State health statistics are available for the zip code 63601, which includes the cities of Desloge, Flat River, Elvins, Ester, Leadington, and Rivermines. Normally, this would represent a much larger population than would actually be affected by the site. In this case, it provides data on the areas exposed either from the site, one of the other piles, or from locations where tailings material has been used for other purposes. State health statistics are also available for the zip codes of Bonne Terre (63628) and Leadwood (63653).

State health statistics for cancer incidence were also searched. These data are tabulations of cancer cases reported to the Missouri Cancer Registry by hospitals in the state. Reported cases are compared to the number of expected cases based on national data from the Surveillance, Epidemiology, and End Results (SEER) program. The SEER program is a National Cancer Institute program that monitors cancer incidence, survival, and mortality in several areas of the country.

Past investigations include a 1985-86 case-control study of lung cancer deaths, and an associated environmental factor study. The studies were conducted of the Flat River area and adjoining communities after a citizen raised concern about an apparent excess of cancer deaths in the area.

Because of concerns about possible long-term exposure of St. Joe State Park employees to the Federal Tailings pile, MDNR requested that blood-lead levels be measured for employees and/or on-site residents. Because the tailings pile makes up a major portion of the park and is used as a recreational area for off-road vehicles, park employees could be exposed to lead in air and soil during these activities and while performing

their normal work duties. Blood-lead samples were taken and analyzed for 16 people, some of whom may be exposed at the park or in the surrounding area. Evaluation of all the data introduced in this section is discussed later in the *Health Outcome Data Evaluation* section.

COMMUNITY HEALTH CONCERNS

To determine if the community had any concerns about health effects related to the site, we asked the St. Francois County Health Department administrator and the head nurse if they had received any concerns from the community. At that time (1993), they said there was very little public concern about the site, that most residents had grown up in the area, and in many cases the piles represent a way of life and income. The administrator and nurse noted that local residents see no health threat from the piles. Some residents even consider the piles to be a special trademark or point of interest. However, according to the administrator and personnel contacted at Desloge City Hall, the piles have been a source of aggravating dust that can be quite thick at times. No marked concern or interest was raised when EPA's investigations and research in the area began in 1990/1991.

In a follow-up telephone conversation, also in 1993, the county health department administrator noted that the department still had not received any comments about health concerns. Since the last meeting with the county health department, there has been more activity at the site, including an EPA investigation and sampling of residential yard soil. Apparently, this increased activity has not raised concern in the community. In a telephone conversation with the mayor of Desloge, he also stated that he had not heard of any site-related concerns.

After release of the Preliminary Public Health Assessment for Public Comment, a public availability session was held by DOH on March 8, 1994, to answer questions and receive comments from the public. Comments gathered during the public availability session and written comments received are included and replies given in *Appendix C*.

Community interest has increased over time. A Citizens Advisory Group, initiated by EPA, holds meetings monthly. Much of DOH and ATSDR's community health education and outreach work is shared and discussed with this group. ATSDR and DOH also participate monthly in the MAC Environmental Information Roundtable meetings where further discussions on the mining wastes are conducted.

PRELIMINARY PUBLIC HEALTH ASSESSMENT

BIG RIVER MINE TAILINGS DESLOGE
(a/k/a ST. JOE MINERALS)
DESLOGE, ST. FRANCOIS COUNTY, MISSOURI

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

On-site and off-site sampling data will be discussed in this section. The concentrations of contaminants found in various environmental media will be compared to values (comparison values) to determine if a contaminant is present at a level that should be further evaluated for the possibility of human exposure and possible public health impact. ATSDR has derived these values from toxicological information presented in their chemical-specific Toxicological Profiles. Environmental Media Evaluation Guides (EMEGs) are derived from the Minimal Risk Levels (MRLs) that is defined as "an estimate of daily human exposure to a chemical that is likely to be without an appreciable risk of deleterious effects (noncarcinogenic) over a specified duration of exposure." EMEGs are based on exposure to a single chemical and do not consider the effects of exposures to chemicals mixtures (ATSDR 1992d). Cancer Risk Evaluation Guides (CREGs) are developed for chemicals that are carcinogenic. CREGs are based on cancer slope factors, which are considered the additional risk of one excessive cancer risk in a population of a million people. Levels above the EMEG (non-carcinogenic) or the CREG (carcinogenic) in any media at a site is called a "contaminant of concern." However, the presence of a contaminant of concern does not necessarily mean that it is a public health threat (ATSDR 1992d).

This public health assessment presents some of those data to demonstrate the amount of contamination present on site and also presents the levels of contamination at other locations where further evaluation is needed.

Toxic Chemical Release Inventory (TRI) databases for the years 1987-1990 were searched to identify facilities that could contribute to the contamination found at and around the Big River Mine Tailings/St. Joe Minerals site. TRI was developed by EPA, and contains information on more than 300 toxic chemicals annually released by certain industries into the air, soil, and water. For the Desloge zip code 63601, the TRI listed one industry that had reported, but no releases were listed. For St. Francois County, the TRI listed two additional industries, but only one had reported releases. None of these industries are considered to be a factor in the contamination at the Big River Mine Tailings/St. Joe Mineral site or in the region.

A. On-Site Contamination

Tailings

On-site sampling has been conducted a number of times. The first major sampling began about 1980, with the report completed in 1983. That sampling was performed by the University of Missouri - Rolla, as requested by MDNR, to determine if the tailings material might be used as agricultural lime. Even though the report concluded that the use of mine tailings as agricultural lime may be acceptable, it stated that caution should be taken because some older piles have much higher concentrations of lead (Wixson et al. 1983). See Table 1 for a summary of sampling events and the range of detected metals in the site pile.

Sampling data were obtained for five of the six piles in the area of concern. Only the data obtained for the Desloge site are listed in the On-Site Contamination section. Data from the other four piles will be listed in the Off-Site Contamination section. Samples were taken 20-40 centimeters (7.8 to 16 inches) below the surface. In the 1983 report, 74 samples were collected from the site and analyzed for lead, cadmium, and

zinc.

Nine samples of the tailings, a duplicate, and background samples were collected in May 1988 by an EPA Field investigation Team (FIT). Depth of sampling was not indicated. Analyses were performed for total metals.

The site was investigated again in July 1990 as part of EPA's Listing Site Inspection (LSI). Fourteen tailings samples, including a duplicate, were collected and a complete metal analysis was run on the samples. Three were subsurface samples taken from one point to better characterize the tailings' subsurface, while the remainder were taken at a depth of zero to six inches. Lead levels in the 11 surface tailings samples ranged from 930 parts per million (ppm) to 1,700 ppm, with a single sample from the site's east area containing 13,000 ppm lead (EPA 1991).

Where subsurface samples were taken, lead was measured at 1,300 ppm at the zero- to six-inch depth, 2,500 ppm at the five- to six-foot depth, 1,600 ppm at the ten- to 11-foot depth, and 910 ppm at the 15- to 16-foot depth. Concentrations of cobalt and nickel also increased significantly from the zero- to six-inch depth to the five- to six-foot depth. The LSI's explanation for this increase was that these metals possibly had migrated down from the upper five feet of tailings. It stated that much more sampling and characterization of the subsurface would be needed to confirm that possibility (EPA 1991).

In 1992, EPA directed a Technical Assistance Team (TAT) from Ecology and Environment, Inc., to further investigate the site. Field work for this investigation was conducted August 19-25, 1992. The investigation included lead screening of 405 tailings and soil samples, including 25 subsurface samples, with an x-ray fluorescence (XRF) spectrophotometer. Of the 405 samples, 51 surface and five subsurface samples were submitted to the EPA Region VII Laboratory for verification of XRF results and analyses for total lead, zinc, cadmium, and arsenic. Laboratory results indicated that lead ranged from 25 ppm in the wooded area where no tailings had been dumped to 5,360 ppm in the tailings (E&E 1992).

Analyses from these investigations indicate that lead, arsenic, cadmium, cobalt, zinc, and nickel are present in the tailings (Table 1). Given this wide variation in sampling, a data gap may still exist. ATSDR considers a surface soil sample to be from zero (surface) to three inches deep. This is the depth at which people are most likely to become exposed to contaminants in the soil. However, considering the ease with which the tailings material can be moved, subsurface conditions may be equally important when considering exposure scenarios.

Groundwater

Until the 1990 LSI sampling, there had been very little groundwater sampling at the site. During the LSI, sampling included the drinking water well at the landfill office, four perimeter monitoring wells with one duplicate, four Geoprobe temporary wells, a leachate sample, and four springs. Water samples were analyzed for total (unfiltered) and dissolved metals (samples for dissolved metals are filtered to eliminate suspended particles from adding to the detected results). Only heavy metals were detected at levels of concern. Contaminants of concern are arsenic, cadmium, cobalt, lead, nickel, and zinc (EPA 1991).

Analysis of the landfill office drinking water well indicated that only lead was detected above the comparison value (EPA Action Level = 15 ppb[(1)]) at 17 ppb total and 14 ppb dissolved. Analyses of other on-site wells, including the monitoring wells, springs, temporary wells, and leachate indicated various contaminants present above comparison values (EPA 1991). The landfill office drinking water well was confirmed to have lead levels above the action level in a follow-up sample collected in August 1992. It contained 16 ppb lead (E&E 1993).

In 1991, two on-site perimeter monitoring wells were sampled for pesticides, volatile organics, base-neutral-acid, total metals, and dissolved metals. They were included as part of a sampling of private wells within a one-mile radius of the Big River Mine Tailings site. Only metals were found (E&E 1991). Refer to Table 2

for a list and range of these contaminants.

Air

In July 1990, the E&E/FIT took air samples using seven air samplers in six locations at and around the site. Samples were taken for a twelve-hour period (from noon to midnight), July 23-28, 1990. Seven samples, plus a field blank were taken for the six day sampling period (7 samples x 6 days = 42 samples, plus 6 field blanks). Two samplers were placed on site to characterize the site and determine if the tailings were being released or transported. One of these samplers was located near the landfill area and the other was placed in the site's northwest section. Two samplers were placed off site in the same location approximately 1,500 feet east of the site to measure the site's influence and to provide a duplicate sample. The remainder were placed in other locations to determine off-site influence of the site at more distant locations, influence from another tailings pile, and to serve as a background. Wind speeds were considered low for the sampling period, so sample levels did not indicate conditions that may be present during strong winds. The sampler located by the landfill area had consistently higher levels than the other on-site sampler. This sampler was influenced by day-to-day activity at the landfill. On the day the landfill was closed, low wind speeds were recorded, and the sampler indicated its lowest level (EPA 1991).

Air samples were analyzed for total metals, with arsenic, cadmium, lead, and zinc being reported in the LSI's Final Report. These detected levels are then compared to ATSDR's conservative comparison values to determine if they should be further evaluated. Arsenic was detected in three on-site samples above the comparison level (CREG) of 0.0002 micro grams per cubic meter ($\mu g/m^3$) of air. Arsenic levels detected were 0.002 and 0.003 $\mu g/m^3$ in different on-site samplers and 0.002 $\mu g/m^3$ in the sampler located west of the Big River pile that could have been influenced by the Leadwood tailings pile. All other samples were reported as undetectable (less than the measurement detection limit) of 0.001 $\mu g/m^3$. Since the comparison value is below the detection limit, it is not known if arsenic was present in the undetected samples at levels above the CREG. Cadmium was detected in eight samples, but reported as undetectable in the others. The detection limit of 0.001 $\mu g/m^3$ was above the CREG comparison value of 0.0006 $\mu g/m^3$. Levels detected for cadmium varied from non-detect at 0.001 to 0.009 $\mu g/m^3$. On-site lead levels ranged from 0.015 to 1.088 $\mu g/m^3$, and zinc ranged from 0.011 to 0.473 $\mu g/m^3$ (EPA 1991). No comparison value is available for lead or zinc. The off-site air sample results will be discussed in the Off-Site Contamination section.

As part of the response action plan, a long-term air quality monitoring network has been established around the Desloge pile. The network consists of four stations that monitor particulate and lead concentrations from the pile. Data generated through this monitoring network will be reviewed and evaluated as part of the on-going public health assessment activities.

B. Off-Site Contamination

Within the area we are discussing in this health assessment are other large tailings piles. Because the Big River Mine Tailings/St. Joe Mineral site is the NPL site under investigation for this document, the influence the other piles have on the environment will be considered in this Off-Site Contamination section. The levels of metal contaminants found in the other tailings piles are listed in Table 3, while the location of the piles can be seen in Figure 2. The LSI report came to the same conclusion, stating "It is important to realize that all of the major tailings piles in this former mining region are contributing to the contamination entering the Big River and its tributaries, and that all are potentially impacting the ambient air. Consequently, the problem is regional and cannot be attributed to only one waste pile" (EPA 1991).

Soil and Tailings

To further highlight the influence of the other tailings piles and the wide use of the tailings in the area, background soil samples were taken during the 1988 site sampling. Three background samples were taken

near a gravel road 2.5 miles northwest of the site. Concentrations ranged from 410 to 570 ppm lead, 97 to 99 ppm zinc, with cadmium being undetected. The report did not explain if tailings had been used on this particular road, although it did mention that tailings are used for road material in the area.

Off-site sampling, again conducted as part of the 1990 LSI, indicated that the site was having an influence on the surrounding area. Surface soil samples (0-6 inches deep) were taken at the nearest residence to the site (approximately 100 feet south of the site). The samples contained levels of metals associated with tailings piles that were above both background levels and comparison values. Results indicated 270 ppm cadmium, 16 ppm cobalt, 650 ppm lead, and 13,000 ppm zinc. These were the highest levels of cadmium and zinc detected in the study. Arsenic and nickel were undetected, which is part of the pattern seen from other samples that have been collected and analyzed.

Approximately 1,000 feet south of the site, samples contained levels of 7.9 ppm cadmium, 23 ppm cobalt, 2,200 ppm lead, 430 ppm zinc, 7.6 ppm arsenic, and 21 ppm nickel. Samples collected approximately 1,500 feet south of the site contained 25 ppm cadmium, 13 ppm cobalt, 1,300 ppm lead, 1,100 ppm zinc, nickel 9.6 ppm, and arsenic undetected. Background samples taken at this time indicated the presence of cobalt at 12-16 ppm, lead 64-76 ppm, zinc 35-67 ppm, arsenic 6.2-9.5 ppm, with nickel and cadmium as undetected (EPA 1991).

Approximately 1,500 feet east of the site, soil was sampled and found to contain 3.2 ppm cadmium, 16 ppm cobalt, 370 ppm lead, 180 ppm zinc, 11 ppm nickel, and 8.2 ppm arsenic. Further sampling east of the site at approximately 1.25 and 2 miles did not indicate elevated levels of metals (EPA 1991).

Similar samples were collected west of the site, where the site is not expected to have an influence. These samples contained lead at 450 ppm and 940 ppm. Other metals were also elevated. This could indicate an influence from the Leadwood tailings pile to the west or from tailings used in that area for fill or construction purposes (EPA 1991).

To better determine the influence of the site to the south, a more in-depth sampling was undertaken in 1992. This sampling, conducted by the TAT from E&E, included a number of residential yards to determine the influence the site was having on them. Samples taken from the yards consisted of ten small sub-samples from different locations combined for the total sample. These samples were of surface soil (0 to 1 inch deep). This should be representative of soils where exposure is most likely to occur (ATSDR considers surface soils as 0 to 3 inches deep). Twenty-two samples were taken in the residential area, consisting mostly of yards and quality control samples (E&E 1992). Contaminants detected in yards above comparison values consisted of:

- ranging from 1.3 to 14.2 ppm
cadmium: ranging from 184 to 3200 ppm
- **lead:** ranging from 94.9 to 918 ppm
- **zinc:** non detectable at 20 ppm
- **arsenic**:

ATSDR uses conservative comparison values to determine if a specific chemical needs further evaluation. Reference levels and their source for the listed chemical are:

- 1 ppm, pica child EMEG
cadmium: no value is presently available for lead, as it is undergoing further
- **lead:** evaluation
- **zinc:** 600 ppm, pica child RMEG
- **arsenic:** 0.4 ppm, CREG

Indoor Dust

During the 1985-1986 DOH Lung Cancer Investigation, indoor dust/dirt samples were taken from household vacuum cleaners to determine possible indoor contamination levels. Household vacuums do not efficiently collect dust and may actually emit dust as they are used. For that reason, dust collected from household vacuums bags cannot be accurately quantified. However, the data were collected and may be useful in identifying areas that need further study. Minimum and maximum levels and the average of metals detected in the vacuum bag samples from the 1985-86 study are listed in Table 4. A single sample measured extremely high at 27,460 ppm of lead. This level was related to hobbies that were done in the house.

To further complicate relating the indoor dust samples to the site, no background samples of metal concentrations were reported. However, Calabrese 1992 reported that 30% of indoor dust originates from outside soil. These findings, along with the high levels of metals known to be in the tailings piles and found inside the homes emphasize the need for a further evaluation of the indoor dust and the exposure potential. New high efficiency vacuum systems and methodologies are now available to better assess household dust.

Air

Air monitoring was first conducted off site by MDNR to determine the effect the Federal tailings pile was having on the immediate area. In this three-year study (1981-1983), a single sampler was located approximately 2,000 feet north of the Federal tailings pile. Particulate matter was sampled and analyzed for lead. The initial sampling period was January-August 1981. Results of the lead analysis were: January-March, 0.14 $\mu g/m^3$; April-June, 1.09 $\mu g/m^3$; and July-August, 0.17 $\mu g/m^3$. The National Ambient (outdoor) Air Quality Standards (NAAQS) for lead per calendar quarter (three months) is 1.5 $\mu g/m^3$. In the period sampled the standard was not exceeded during the sampling period, but by comparison, the six-year (1985-1990) maximum for a 3-month period at the St. Louis County South Lindbergh monitoring site was less than 0.4 $\mu g/m^3$.

The total suspended particulate (TSP) annual geometric mean for the same period was 50.55 $\mu g/m^3$ for 1981, 35.47 $\mu g/m^3$ for 1982, and 47.43 $\mu g/m^3$ for 1983. The NAAQS for the annual geometric mean for TSP is not to exceed 75 $\mu g/m^3$ (EPA 1991). Given these values, the particulates would have been within the limit. The standard has been lowered and is presently 50 $\mu g/m^3$.

A data gap exists because air sampling results are ten years old, and major changes have occurred since the original sampling at the Federal tailings pile. Further, considering the size of the park and tailings pile, the area's environment, and the use of only one air sampler with no established background level, adequate ambient air levels likely could not have been determined. Also, samples were only analyzed for lead when other contaminants are known to be present in the tailings.

The Federal tailings pile/St. Joe State Park is located near Flat River, Missouri, and is approximately two miles from the Big River Mine Tailings/St. Joe Minerals site. The information was included to demonstrate that there are other sources of dust that can affect the ambient air of the area, and that the site's tailings pile cannot be singled out as the only source of contamination in the area.

More recent off-site air monitoring related to the Big River Mine Tailings/St. Joe Minerals site was completed as part of the 1990 LSI. In the 1990 LSI sampling, multiple air samplers and a background sampler were placed at different locations around the site. Samples were taken for six consecutive days, for 12 hours a day. Samples were analyzed for arsenic, cadmium, lead, and zinc. Detected arsenic levels ranged from non-detectable at 0.001 $\mu g/m^3$ to 0.002 $\mu g/m^3$; cadmium ranged from non-detectable at 0.001 $\mu g/m^3$ to 0.008 $\mu g/m^3$; lead ranged from 0.008 to 0.127 $\mu g/m^3$; and zinc ranged 0.14 to 0.48 $\mu g/m^3$. Wind speed during the six days of sampling ranged from 1.8 to 5.4 meters per second or 4.0 to 12.0 miles per hour (EPA 1991). A data gap exists in the actual values that may be present during windy conditions because sampling was

conducted when winds were calm and were performed for only six days. In this sampling, arsenic levels were detected above the CREG comparison value of 0.0002 $\mu g/m^3$. Cadmium was also measured above it's CREG comparison value of 0.0006 $\mu g/m^3$. Levels could be higher when stronger winds are present.

Air monitoring was conducted at the Federal tailings pile during and for three days after the St. Joe Grand Prix, a major gathering of off-road vehicle riders who use the tailings pile for their activities. Levels of lead in ambient air at the park ranged from 0.68 $\mu g/m^3$ (the detection limit) to 11.26 $\mu g/m^3$. Monitoring was conducted October 5-8, 1991, on a 24-hour basis at four stations. The Federal tailings pile makes up a major portion of the St. Joe State Park.

Groundwater

Public Water Supply Wells

Water for the cities adjacent to the Big River Mine Tailings/St. Joe Minerals site is supplied by the Flat River Water District. The water district includes Flat River, Elvins, Desloge, Leadington, Ester, and Rivermines. The water district obtains its water from two main sources, including a well in Desloge and a flooded mine shaft in Rivermines (EPA 1991). Sampling of these water sources was part of the 1985/86 DOH Lung Cancer Study. Sample results indicated that the Desloge well contained five parts per billion (ppb) lead. The Rivermines well (mine shaft) contained a higher level of lead at 49 ppb. At the time of sampling, both wells were below the MCL of 50 ppb (DOH 1986a). The Environmental Protection Agency has since replaced the MCL with a public drinking water Action Level of 15 ppb (EPA 1994).

MDNR is responsible for monitoring public water systems in Missouri. The agency was asked for the present water analyses of the Flat River Public Water System. Results from sampling conducted in 1991 indicate that the lead level is well within the Action Level of 15 ppb (less than five ppb). Other metals were within limits or undetectable.

Private Wells

There is an unknown number of private wells outside of the Flat River Water District. Private well sampling related to the site was first conducted in 1990, but only one well was sampled. That well is located about one-half mile southwest of the site. The owner had complained of having health problems, so an analysis was performed on the well water, including total and dissolved metals and a full target compound list of chemicals. Analysis results indicated total lead present at 29 ppb and dissolved lead at 25 ppb, which are above the 15 ppb Action Level for public water supplies.

During the 1990 LSI, the E&E/FIT sampled two private drinking water wells. One was the on-site drinking water well at the landfill office, and the other was a residential well approximately 750 feet south of the landfill office. The landfill office well has been previously discussed in the On-Site Contamination section. The residential well contained 26 ppb total zinc and 31 ppb dissolved zinc. No total lead was detected, and the dissolved lead analyses was invalidated. Arsenic, cadmium, cobalt, and nickel were undetectable.

The E&E/FIT then conducted a more intensive sampling of private wells around the site in 1991. Forty-four private wells (along with four duplicates) were sampled within a one-mile radius of the Big River Mine Tailings/St. Joe Minerals site. Two of the wells were randomly selected and sampled for base-neutral-acids, pesticides, volatile organics, total metals, and dissolved metals. The remaining 42 wells were sampled for total and dissolved metals. All of the samples were sent to the EPA Region VII laboratory for analysis.

Analyses results showed that no detectable levels of volatiles, semi-volatiles, or pesticides were found in the two wells sampled for those contaminants. Total lead was detected in five private wells at levels ranging from 5.9 to 32.9 ppb. Dissolved lead was found in only two residential wells at 6.6 and 25.6 ppb. The residential well, previously tested in 1990, measured 16 ppb for total lead, while dissolved lead was undetected. Total

and dissolved cadmium was not detected in any of the private wells. Total zinc was detected in 19 of the wells sampled, ranging from 20.1 to 457 ppb. Dissolved zinc was detected in 20 private wells with levels ranging from 20.3 to 463 ppb. Several other metals were detected at varying levels, but reportedly at levels below MCLs (E&E 1991).

In EPA's most recent sampling of the site, 12 residential wells were sampled. One sample was taken as near the wellhead as possible, and another was taken at an indoor tap. This procedure was used to determine if measurable contamination was from the groundwater or the indoor plumbing. Samples were collected from several wells that previously had shown lead contamination. Of the 12 residential wells sampled, one residential well contained lead at 27 ppb, which exceeds the 15 ppb Action Level for public water supplies, and cadmium was present in that well at 12 ppb, which exceeds the 5 ppb MCL. A second well contained lead at 16 ppb at the sample point nearest the well. Another residential well contained cadmium at 6 ppb at the indoor tap, but cadmium was not detected at the well head. Several other water samples were taken during this investigation: from the landfill office, from springs, and for QA/QC confirmation (E&E 1993).

Surface Water and Sediment

Surface water and sediment sampling data are available for a 60-mile stretch of the Big River. The data are compiled under the following headings to show the impact from the site and to show how other similar tailings sites in the area are likely to contribute to the river's contamination.

Surface Water

In 1982, the U.S. Fish and Wildlife Service (U.S. F&WS) conducted surface water sampling at the Big River Mine Tailings/St. Joe Minerals site. Grab samples were collected during low, medium, and high stream flow conditions. Samples were collected from the Big River, approximately five miles downstream from the site, 16 miles upstream from the site (background) and at Washington State Park, approximately 37 miles downstream from the site. The samples were analyzed for total and dissolved metals. Lead, cadmium, and zinc were determined to be the contaminants of concern in the Big River. The levels for total lead and cadmium had increased for all water levels (low, medium, and high flow conditions) below the Big River tailings pile as compared to background (with one exception). In samples collected at Brown's Ford, approximately 60 miles downstream of the site, contaminant levels had all decreased except dissolved lead, which increased slightly. The maximum total lead concentration of 680 ppb (under high flow conditions) was detected at the Washington State Park sampling site. Concentrations are provided in Table 5.

During its 1990 LSI, E&E conducted water sampling of the Big River and it's tributaries. At 21 locations a grab sample was taken, including a duplicate. Background samples were collected approximately 16.5 miles and 9.7 miles upstream of the site. Sampling locations included tributaries that drain other tailings piles, as well as the Big River upstream of, parallel with, and downstream from the site. Lead and zinc were the only metals found at elevated levels. Refer to Table 7 for a summary of concentrations detected and the sampling locations.

Levels of contaminants of concern were lowest at the upstream background sampling points, and increased as sources of contamination (site, tributaries) affected the Big River. Levels of contaminants dropped off downstream as the effect from the tailings decreased.

Two water quality studies conducted on the Big River were reviewed for this public health assessment. The first study was conducted during the summers of 1962 and 1963. A follow-up study was conducted in 1977 to determine changes and obtain additional data. The studies were designed to determine water quality through species diversity evaluation and water chemistry comparisons to other water bodies in the region. The 1962/63 study determined that a 40-mile stretch of the Big River, downstream of the site was of poorer quality than similar water bodies in the region. The 1977 study determined that the zone of degradation terminated upstream from the Washington State Park, that the degradation had not increased since the earlier study, and that the likely cause of the poor species diversity was from a change of substrate (sediment)

because of mine tailings entering the river. The water chemistry data indicated that the mine tailings sites did not greatly change the Big River's water chemistry from comparison rivers (EPA 1978b).

Sediment

Concentrations of contaminants in Big River sediment were measured as part of the 1982 U.S. F&WS report. Samples were taken at the same sampling points as the surface water. Lead, cadmium, and zinc were the main contaminants detected. Background samples were taken at the upstream location and contained the lowest levels of contaminants analyzed in the sampling. Sediment samples were then collected at approximately five miles below the site. Results indicated a large increase in the level of contamination compared to the upstream location. Sediment samples taken farther downstream indicated a decreasing trend as distance increased from the site. See Table 6 for contaminant concentrations in the sediment.

Concentrations of contaminants in sediment were also measured as part of the 1990 E&E LSI report. Samples were taken from the same locations as the 1990 water samples, and consisted of 21 samples, including a duplicate. The sediment samples were composite samples. Background samples were taken at approximately 16.5 miles and 9.7 miles upstream from the site. Sampling locations included tributaries that drain other tailings piles, multiple locations from the Big River along the site, and various locations on the Big River. A summary of the concentrations of cadmium, lead, and zinc, as well as the sampling locations, are listed in Table 8. Concentrations varied, depending on the influence by the site and other tributaries that drained the various tailings piles.

Aquatic Biota

Studies were conducted to determine the effects on aquatic biota after the major collapse of tailings into the Big River in 1977. In a study conducted by MDOC, fish (especially bottom feeders) found downstream of the site, contained elevated levels of lead in their edible tissues. The study found that averages for sucker-type fish contained from 0.4 to 0.7 ppm lead in edible fillets, with a few individual fish exceeding 1.0 to 1.28 ppm. The World Health Organization (WHO) has set 0.3 ppm lead as a maximum safe level in food for adults. Because of this report, DOH and MDOC issued a press release discouraging local residents from eating bottom-feeding fish taken from the 50-mile stretch of the Big River from Leadwood to Mammoth Access (MDOC 1980). The Missouri Department of Health presently releases an annual fish advisory. It recommends that carp, redhorse, and suckers taken from the Big River near the site to the where its joins the Meramec River should not be eaten (DOH 1993).

In a 1982 report, further findings of biodegradation and fish contamination were released by the U.S. F&WS. This study included sampling at a number of locations above (background) and below the site to determine the amount of contamination that had actually occurred. Samples of plants, crayfish, freshwater mussels, and fish were collected. Background samples were taken at Irondale (16 miles above the site). Samples were taken at five miles below the site, at Washington State Park (37 miles below the site), and at Brown's Ford (60 miles downstream of the site).

Findings of the report indicated that the highest residues of lead, cadmium, copper, and zinc were found in algae below the site. Lead levels were lowest at the background location at 16.3 ppm, while samples five miles below the site measured 1,210 ppm, Washington State Park measured 623 ppm, and Brown's Ford measured 660 ppm. Concentrations of all the metals followed a similar pattern in water willow (an emergent plant). Concentrations of metals were found to be higher in willow roots than in stems and leaves.

The study also showed that in crayfish, levels of lead and cadmium were found to be elevated at all locations downstream from the site, with the highest concentration measured from the sample point five miles below the site at 140 ppm. At Irondale, background lead levels were 1.4 ppm, a concentration level comparable to levels in uncontaminated laboratory-raised crayfish.

Freshwater mussels were collected from the same locations on the Big River, and from an additional location

at Leadwood. Specimens could not be found at the sample point five miles below the site. The Leadwood sample site is affected by the Leadwood tailings pile. At Brown's Ford, the farthest downstream sample location, the highest mean level of lead detected was 18.5 ppm in the shell and 386.67 ppm in the soft tissue. Concentrations of cadmium, copper, and zinc followed a similar pattern with the highest concentrations occurring at Brown's Ford and the lowest in the background samples at Irondale.

Samples of edible portions of fish collected at various locations downstream from the site had elevated levels of metals. Lead concentrations were highest in the Redhorse sucker species, with the exception of one catfish that contained 12 ppm lead, taken at Washington State Park. Catfish samples taken from affected areas also had elevated levels of lead compared to background samples. Smallmouth bass were also sampled and had levels of lead above the background level of 0.01 ppm. See Table 9 for a summary of the levels of lead and cadmium detected in the Big River biota.

C. Quality Assurance and Quality Control

Various people, organizations, and contractors have been involved in the sampling, research, and analyses at this site, resulting in Quality Assurance and Quality Control (QA/QC) information of varying degrees of accuracy and precision. Some soil analysis levels from the EPA Region VII Laboratory were labeled with a J, indicating data not valid by approved QA/QC procedures. According to EPA, "J-coded data as reported by a Contract Laboratory Program (CLP) lab are chemicals whose concentrations occur above the CAP contract reportable concentration limits for Quality Assurance/Quality Control (QA/QC). Thus, J-coded data are useful for site characterization purposes but have limited value for enforcement proceedings because they represent an estimated value above the contract reportable limit for meeting the contract QA/QC requirements."

In preparing this public health assessment, DOH and ATSDR have relied on the information provided in the referenced documents and have assumed that adequate quality assurance and quality control measures were followed with regard to chain-of-custody, laboratory procedures, and data reporting. The validity of the analysis and, therefore, the conclusions in this public health assessment are valid only if the referenced information is complete and reliable.

D. Physical and Other Hazards

Physical hazards at the site consist mainly of steep drop-offs from the tailings piles themselves or where they lead to a steep drop-off to the river below. An accident occurred when an ORV plunged off one of the tailings piles. Further collapses or washouts of the tailings are possible. The only other physical hazards at the site are old mechanical equipment and old drainage structures. Workers and trespassers are expected to be at risk of harm because of these physical hazards.

PATHWAYS ANALYSIS

This section addresses the pathways by which people in the area surrounding the site could be exposed to contaminants at, or migrating from, the site. If it is determined that exposure to chemicals not related to the site is also a concern, these pathways will be evaluated as well. When a chemical is released into the environment, the release does not always lead to exposure. Exposure only occurs when a chemical comes into contact with and enters the body. For a chemical to pose a health risk, a completed exposure pathway must exist. A completed exposure pathway consists of five elements: 1) a source and a mechanism of contaminant release to the environment; 2) transport through an environmental medium (e.g., air, soil, water); 3) a point of human contact with the contaminated medium (known as the exposure point); 4) an exposure route (e.g., inhalation, dermal absorption, ingestion) at the exposure point; and 5) a human population at the exposure point. See Table 10 for a chart identifying the completed exposure pathways at the Big River Mine Tailings/St. Joe Minerals site.

Exposure pathways are classified as either completed, potential, or eliminated. Completed exposure pathways

exist when all five elements are present. Potential exposure pathways are either 1) not currently complete, but could become complete in the future, or 2) are indeterminate due to lack of information. Pathways are eliminated from further assessment if they are determined to be unlikely to occur.

A time frame given for each pathway indicates whether the exposure occurred in the past, is currently occurring, or will occur in the future. For example, a completed pathway occurring only in the past indicates that exposure has occurred, but does not currently exist and will not exist in the future. Human exposure pathways are evaluated for each environmental medium possibly impacted by site-related contaminants. The toxicological implications of the various exposure pathways identified as being of concern will be evaluated in the *Public Health Implications* section.

A. Completed Exposure Pathways

There are numerous completed exposure pathways occurring at the Big River Mine Tailings/St. Joe Minerals site, in the neighboring communities, and at other tailings piles in the region. Exposure routes are expected to have occurred through ingestion, inhalation, and dermal contact. Considering the contaminants (metals) present at the site and the fact that they are not readily absorbed through the skin, dermal contact has been eliminated as a significant exposure route. Inhalation and ingestion exposures have occurred in the past, present, and will continue until remediation is completed to stop the movement of tailings into the environment. The extent of these exposures is not known because sampling data were not available to determine the level of exposure, the duration of exposure, or the frequency of exposure. The tailings material has been processed and disposed in the environment where human exposure occurs. Weathering (natural decomposition to basic elements) of this material has made the contaminants available to people.

Air Pathways

Ambient Air

Mine tailings from past mining and milling operations were deposited on the ground and piled as high as 100 feet at the Big River Mine Tailings/St. Joe Minerals site. The tailings contain heavy metals. Part of the tailings are powdery, so the material is carried as particulates through the air when the wind or human activities, such as off-road vehicles use, disturb the tailings. Strong winds have reportedly carried clouds of dust from the tailings as far as one mile.

The fact that similar tailings piles are located throughout the area complicates evaluating how much of the airborne particulates come from the site. Particulates from the site can mix with the particulates from other tailings piles and increase the amount of heavy metals available to people living and working in the area. People living closest to the site/piles would be most affected by site contaminants.

During a normal work week, there are four full-time landfill employees, with the asphalt contractor having three full-time and two part-time employees. Residential areas adjoin the site on the southeast. When the wind blows, the people who live in those homes or who are working or trespassing on the site are exposed to airborne particulates through inhalation. Incidental ingestion of contaminants is another possible route of exposure.

Indoor Dust

When particulates from the site become airborne, they can enter nearby buildings, as described previously, and become part of the indoor air. The collection of vacuum cleaner dust from the area in the 1985/86 DOH Environmental Study supports this theory. People living in the homes near the tailings piles are, therefore, exposed to contaminated particulates through inhalation and incidental ingestion while inside their homes, as well as when they are outside. Indoor exposure may be greater than exposures occurring outside because the particulates are trapped and more concentrated. In addition, other indoor air pollutants (i.e. cigarette smoke, chemicals) could mix with airborne metals and expose residents to higher levels of contamination than those

coming from only the tailings piles. The houses within a mile of the site are an estimated 20 to 30 years old. Therefore, people could have been exposed to the contaminated indoor dust for that long.

Soil Pathways

Because the tailings are at ground surface, the contaminated piles are considered accessible soils. Because of wind and erosion, the contaminated soils have spread to surrounding areas. A total of seven full-time and two part-time employees who work at the site now and those who worked on the site in the past, as well as trespassers, have been exposed to the contaminants through incidental ingestion and inhalation of particulates.

As discussed in the Air Pathways section, soils are carried from the site by the wind. When the airborne dust settles, the contaminants from the site become part of the soils in neighboring yards. People who live and work in the area close to the site are exposed to soil contamination through incidental ingestion and inhalation of particulates.

As with the airborne particulates that settle in the soils outside, the airborne particulates that enter buildings also settle as dust. People, especially crawling infants, are exposed to the contaminants through ingestion and inhalation.

In the background section of this document, other uses of the tailings were discussed. Tailings have been used for many purposes around the area, including as fill material, road surfaces, and on roads to aid traction in the winter. The number of people that may be exposed to contaminated soils because of these practices cannot be determined. However, people who do come into contact with the relocated tailings can be exposed to the contaminants through incidental ingestion and inhalation of particulates.

Groundwater Pathways

Lead was found in some private off-site wells and the on-site drinking water well. Residents, past employees, and the seven to nine present workers at the landfill who drink the contaminated well water, are exposed to lead through ingestion.

Groundwater flow at the site and in the region has been affected by the extensive mining conducted there. Numerous exploratory drillings have been conducted in the area, providing another path to groundwater. Determining what contamination in the off-site groundwater is attributable to the Big River Mine Tailings/St. Joe minerals site or the other similar tailings piles in the area would be difficult.

Towns and communities in the vicinity of the site depend on groundwater for drinking and industrial water supplies. There are at least 42 private wells within one mile of the site. Lead has been detected in the municipal water supply, which serves 16,245 people.

All private wells used in the area may not have been identified and tested. Lead was found in five private wells, and zinc was detected in 20 private wells. This would indicate approximately 12-15 additional people are exposed to lead and an estimated 40-50 people are exposed to zinc through their private water supply.

Fish Pathways

Heavy metals from the tailings piles have been washed into the Big River, and have contaminated the water and sediments. Aquatic animals, especially bottom and filter feeders, consume the contaminants with their food. Some of the metals found in the water and sediments can accumulate in animals. Elevated levels of metals found in aquatic animals include lead in fish, crayfish, and mussels; cadmium in crayfish and mussels; and copper and zinc in mussels. People eat fish from the river, especially suckers and catfish. People who eat crayfish and mussels from the Big River are also at risk of becoming exposed to the contaminants. The number of people who catch and eat the contaminated fish, the quantity they eat, and the frequency that the

contaminated are eaten is unknown. This leaves a data gap as to the human health risk associated with this specific pathway.

B. Potential Pathways

Surface Water and Sediment

The surface water and sediments in the Big River adjacent to the site have been contaminated with tailings washed and collapsed into the river. People use the river for fishing and other activities, upstream and downstream of the site, but the extent of human activity on the river at the site is unknown. If people come into contact with the water and sediments at the site, some amount of exposure to the contaminants is expected to occur through incidental ingestion and, perhaps, through inhalation of mists and particulates.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

Introduction

In this section, DOH/ATSDR discuss health effects that could result from exposures to site contaminants. People can only be exposed to a site contaminant if they come in contact with it. People can be exposed by breathing, eating, or drinking the contaminant, or by contacting (skin contact) contaminated water, soil, or air.

In order to understand health effects that may be caused by a specific contaminant, it is helpful to review factors related to how the human body processes the chemical after exposure. Those factors include the exposure concentration (level), the duration of exposure (how long), the route of exposure (breathing, eating, drinking, or skin contact), the chemical availability (how easily the body absorbs the contaminant), and the multiplicity of exposure (combination of contaminants).

When exposure occurs, individual characteristics such as age, sex, nutritional status, health status, lifestyle, and genetics influence how the chemical is absorbed, distributed, metabolized (processed), and excreted (eliminated). Together, those factors determine health effects that exposed people may have.

To determine the possible health effects of specific chemicals, ATSDR searches scientific literature. The information then is compiled and published in a series of chemical-specific ATSDR documents called *Toxicological Profiles. Toxicological Profiles* are references that describe adverse health effects that could be associated with exposure to a specific chemical in the environment. In addition, they include health guidelines such as ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs), reference concentrations (RfCs), and cancer slope factors (CSFs). When RfDs, RfCs, and MRLs are not available, a no-adverse-effect level (NOAEL) or lowest-adverse-effect level (LOAEL) may be used to estimate levels at which adverse non-cancerous effects are not expected.

DOH/ATSDR compares contaminant concentrations in different environmental media (soil, air, water, and food), to which populations may be exposed daily, to a variety of health guidelines. This will determine whether exposure to given levels of contaminants is likely to cause an increased risk of developing cancer and/or non-cancerous adverse health effects. ATSDR's MRL is an estimate of daily human exposure to a chemical likely to be without appreciable risk of harmful (non-cancerous) effects over a specified duration of exposure. MRLs are based on human and animal studies and are reported for acute (less than or equal to 14 days), intermediate (15-364 days), and chronic (365 days and greater) exposures. If an individual's daily exposure is below the MRL, adverse health effects are not expected. A RfD is EPA's estimate of a person's daily exposure through ingestion of a contaminant over a lifetime (70 years), that is not expected to result in harmful effects. The estimate includes consideration for people who may be more sensitive to the contaminant's toxicity than the average population. Likewise, a RfC is EPA's estimate for the human

population, including sensitive sub-populations, of the daily exposure by the inhalation route likely to be without appreciable risk of harmful (non-cancerous) effects during a lifetime.

To evaluate exposure to carcinogenic chemicals, EPA has established cancer slope factors (for inhalation and ingestion) that define the relationship between exposure doses and the likelihood of an increased risk of cancer compared with non-exposed populations (controls). Usually derived from animal or occupational studies, cancer slope factors are used to calculate the exposure dose likely to result in one excess cancer case per one million people exposed over a lifetime (70 years).

ATSDR's estimation of human exposure to contaminated media uses media-specific rates for adults and children. The rates are calculated by multiplying the contaminant concentration by the ingestion rate for an adult or a child, then dividing that number by the appropriate standard body weight (70 kg for adults, 16 kg for a child). The water ingestion rates used for adults and children are 2.0 Liter (L)/day and 1.0 L/day, respectively. ATSDR uses an inhalation rate of 23 cubic meters per day (m^3/day) for adults and 15 m^3/day for children. Some exposures occur on an intermittent or irregular basis. In those cases, an exposure factor (EF) is calculated that averages the dose over the exposure period.

The maximum contaminant concentration detected in a particular medium is used to determine estimated exposure. Using the maximum concentration provides an evaluation that is protective of public health.

Lead

The presence of lead in groundwater, soils, and dust has led to human exposure. The following discussion will describe how lead contamination in each media has resulted in exposure and what may be expected to result from the exposure.

Groundwater:

Lead has been detected in municipal and private drinking water wells in communities around the site. Home plumbing is a common source of lead in drinking water. Lead is also naturally occurring in soils and groundwater at various levels, depending on the region of the country. Lead does not readily absorb through the skin, so dermal contact is not an important route of exposure.

Lead has been detected in municipal wells at a maximum of 49 ppb, and in private wells at a maximum of 32.9 ppb. Recent monitoring indicates that the level of lead in the public water is well below the current EPA Action Level of 15 ppb (EPA 1994). At that level or above, EPA may recommend an action (such as filtration) be taken to lower the amount of lead in the water. No studies are available to clearly determine how much lead in drinking water will result in increased blood-lead levels in people. For that reason, any lead present in water supplies is a reason for concern.

Soil/Dust

Although lead is naturally occurring, in this region the practice of depositing mine tailings at ground level has made lead more accessible to people. Lead is also a problem in older homes where lead paint has been used. In addition to exposure to lead through drinking water supplies, people in the area of the site (and the similar tailings sites throughout the area) have been exposed to lead through incidental ingestion of soils and dust contaminated with lead, both on the site and in yards and homes near the site. Because dust is airborne before it settles to become part of the soil or in-home dust, lead, as particulates, has likely been inhaled as well.

Lead exposure probably is greatest in the indoor atmosphere, where the contaminant is trapped and dispersed over a confined area. Lead was sampled in household vacuum cleaner dust at a maximum of 5,280 ppm, with a single sample measuring 27,460 ppm (this concentration was present in the vacuum dust in a home where a resident worked with lead products as a hobby). The concentrations are an indication of the amount of lead in dust that was, at some point in time, distributed throughout the households and accessible to the occupants of

the homes. Few studies are available that indicate how much lead in dust and soils may result in an increase of blood-lead levels when lead is ingested or inhaled. Madhaven, et.al. derived a "safe" or permissible level of lead in soil (or settled indoor dust, which is considered a type of soil for this evaluation) (Madhaven et.al. 1989). The authors proposed permissible levels of lead in soils ranging from 250 ppm to 1,000 ppm depending on site conditions. The 250 ppm value applies to a worst-case scenario in which an area without grass cover is repeatedly used by children under five years of age, among whom putting objects in their mouths is expected behavior. In this situation, it was estimated that a soil-lead concentration of 250 ppm would add, at most, about 2 micro grams per deciliter (μg/dL) to the blood-lead level of children. Levels of lead in residential soil, in the range of 400 to 500 ppm, are not likely to be considered harmful to children. Lead has been found on site at a maximum of 13,000 ppm and in off-site residential soils (e.g., 2,200 ppm) at levels that are considered unsafe for children. The tailings are also spread throughout the region where children have easy access to them. This constitutes a completed exposure pathway to the contaminated soils and dust that is a public health concern.

At very high levels of exposure, hematopoietic (production and development of blood cells) and nervous systems are susceptible to harmful effects of lead. Hematopoietic alterations may result in anemia (WHO 1977). The nervous system is another target organ of lead toxicity. Lead damages arteries and capillaries causing cerebral edema, increased cerebrospinal fluid pressure, neuronal degeneration, and glial (non-nervous or supporting tissue of the brain and spinal cord) proliferation (rapid reproduction). Wrist-drop and foot-drop are signs of impairment of the peripheral nervous system (damage of motor nerves). This syndrome occurs mainly from exposure to high lead levels in occupational settings. These alterations are manifested clinically as ataxia (loss of muscle coordination), stupor (unconsciousness), convulsions, and coma. This syndrome is observed in children at blood-lead concentrations of 70 μg/dL. In adults it is observed at 80 μg/dL.

At lower levels of exposure, such as those for people near the site who are exposed to lead through their water supply and indoor and outdoor soils, other signs of lead toxicity have been observed in children, such as adverse effects on the central nervous system, kidney, and hematopoietic system, as well as decreased intelligence and impaired neurobehavioral development (CDC 1991). This may be due to alterations in neurotransmitter function and the flow of calcium ions. Animal studies have shown that lead can affect reproductive functions in males and females causing sterility, miscarriage, and neonatal death.

Studies on rodents have shown carcinogenicity of the kidney given large doses of lead, but we have no proof that lead causes cancer in humans (ATSDR 1993b). EPA considers some forms of lead as "B2," or a probable human carcinogens because, despite the inadequacy of studies of lead carcinogenicity (ability to cause cancer) in humans, there are sufficient animal studies that show kidney carcinogenicity.

Several populations may be especially sensitive to the adverse health effects caused by lead. Pregnant women, fetuses, and children are particularly affected by lead exposure. Children with glucose 6-phosphate dehydrogenase deficiency (most prevalent among blacks) have greater blood-lead levels than non-deficient children with similar exposure. People with sickle-cell anemia may be especially sensitive to neurological effects of lead exposure. Children with pica (a syndrome that causes uncontrolled ingestion of non-food substances) are also at greater risk because they may ingest more contaminated soil. Middle-aged men are at risk for increased blood pressure resulting from lead exposure. In addition, those with dietary deficiencies in calcium, iron, and zinc may be susceptible to the adverse effects of lead. Also, people who work in certain hobbies or industries, such as in the production of storage batteries, chemical substances such as paint and gasoline additives, metal products such as sheet lead, solder and pipe, and ammunition, may also be at greater risk for adverse health effects because of exposure at the work place as well as at home. Those workers may also be exposed to lead through dermal contact because of the organic forms of lead found in some industrial processes (ATSDR 1990b).

Cadmium

Cadmium has been detected in tailings, soil and dust, surface water, and biota. Exposure to cadmium at the Big River Mine Tailings/St. Joe Minerals site and the surrounding area follows similar pathways as exposure

to lead. Ingestion and inhalation are the main routes of cadmium into the body. Actual exposure levels to cadmium are not known, but the potential for cadmium exposure is present because private yard soil contains up to a maximum of 14.2 ppm, tailings piles contain up to a maximum of 1,870 ppm, and indoor dust contains a maximum of 31 ppm.

Ingesting low levels of cadmium over long periods of time leads to a build-up of cadmium in the kidneys. This cadmium build-up can cause abnormal kidney function. Evidence exists that lead and cadmium act synergistically. That means that exposure to one can enhance the toxicity of the other on the kidney (ATSDR 1989a). Ingestion of cadmium can also cause bones to lose calcium and become fragile and break easily. It is not known if cadmium exposure affects reproduction or harms unborn babies. Inhalation of low levels of cadmium over several years can lead to similar health effects as seen from ingesting cadmium. Workers who inhale cadmium for a long time may have an increased risk of getting lung cancer.

Evidence that cadmium inhalation can cause cancer in humans is rather weak, but it has been shown to cause lung cancer in rats (ATSDR 1993c). According to the EPA, cadmium is classified as a "B1" carcinogen. This means that it is a probable human carcinogen because, although limited human studies exist, there are sufficient animal studies that show cadmium carcinogenicity (ATSDR 1989a).

Inhalation of cadmium has the possibility of causing cancer in humans. Cadmium was measured at a maximum concentration in air of 0.009 $\mu g/m^3$ during six half-days of sampling during EPA's Listing Site Investigation. That level was detected in a 12-hours, 6-day sampling period and may not represent the true value of cadmium in the air. Therefore, information available may not be representative, and cancer risk cannot be adequately addressed. The level is above ATSDR's Cancer Risk Evaluation Guide value of 0.0006 $\mu g/m^3$ where the additional risk of one excessive cancer in a population of a million is possible.

Arsenic

Arsenic is a natural element in the environment, and low levels are present in soil, water, and air. Soil contains the most arsenic, with average levels of about 5 ppm. Levels in food usually range from 20 to 140 ppb, and levels in water are normally about 2 ppb. Mean levels in ambient air usually range from less than 0.001 $\mu g/m^3$ in remote areas to 0.02 to 0.03 $\mu g/m^3$ in urban area with contributing industries such as coal-fired power plants (1993a).

Arsenic has been detected in tailings, soils, and dust on site and in the surrounding area of the Big River Mine Tailings/St. Joe Minerals site. Pathways and the opportunity for exposure to arsenic is similar to lead and cadmium. Levels at the site and certain locations around the site, including household dust, have been found to be slightly elevated. Arsenic in tailings was detected at a maximum level of 14 ppm and in indoor dust at a maximum of 13.2 ppm. Residential soils near the site were shown to contain a maximum of 20 ppm.

It is not known what levels of exposure are actually occurring in the area, but low levels of inorganic arsenic (ranging from 300 to 30,000 ppb in food) can cause irritation to the stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea. Other effects one might experience from ingesting arsenic include decreased production of red and white blood cells, abnormal heart function, blood-vessel damage, and impaired nerve function, which causes a "pins and needles" sensation in the hands and feet (ATSDR 1993).

There is clear evidence from studies in humans that exposure to inorganic arsenic may increase the risk of cancer. Most studies have involved occupational settings where most researchers observe that the risk of lung cancer increases as a function of exposure level and duration. Other studies suggest that people who live near smelters, chemical factories, or waste sites with arsenic, may have a small increased risk of lung cancer (ATSDR 1993). Arsenic has also been shown to cause cancer when it enters the body by the ingestion route. The main carcinogenic effect from ingestion of inorganic arsenic is skin cancer, but it may also increase the risk of internal tumors (mainly of the liver, bladder, kidney, and lung). According to EPA, arsenic is

classified as a "A" carcinogen, which means that arsenic is a human carcinogen (ATSDR 1993a).

Inhalation of arsenic is known to cause cancer in humans. Arsenic was measured at a maximum concentration in air of 0.003 $\mu g/m^3$ during six half-days of sampling for EPA's Listing Site Inspection. That level was detected in a 12-hours 6-day sampling period and may not represent the true value of arsenic in the air. Therefore, information available may not be representative, and cancer risk cannot be adequately addressed. The level is above ATSDR's conservative Cancer Risk Evaluation Guide value of 0.0002 $\mu g/m^3$ where the additional risk of one excessive cancer in a population of a million is possible.

Zinc

Zinc has been detected at elevated levels in the tailings, soil, air, household dust, and river water. Zinc is an essential element in the human diet and toxicity due to environmental zinc is rare. Zinc intoxication occurs mainly due to excessive supplement intake. Exposure pathways to zinc in the region would follow the patterns of the other metals and enter the body through ingestion and inhalation. Exposure to small amounts of zinc compounds occur every day from the food and water we consume. Average zinc intake in the diet ranges from 7 to 16.3 milligrams (mg) per day. The levels of zinc that produce adverse health effects are usually much higher than the Recommended Daily Allowances (RDAs) for zinc of 15 mg/day (men) and 12 mg/day (women). If large doses of zinc (10 to 15 times higher than the RDA) are ingested for even a short time, stomach and digestion problems might occur. Too much zinc might also interfere with the body's immune system and the body's ability to take in and use other essential minerals such as copper and iron. Normally, zinc leaves the body in urine and feces.

Taking in too little zinc is as much of a health problem as taking in too much zinc. Without zinc in the diet, people can experience loss of appetite, decreased sense of taste and smell, slow wound healing, and skin lesions (ATSDR 1989b).

Health effects from excessive zinc exposure are not expected to be a problem from normal exposures in the area. If other sources of high zinc exposure or if dietary supplements of zinc are taken, the additional exposure from the site could increase values above the recommended intake.

B. Health Outcome Data Evaluation

The Missouri Department of Health 1985-86 case-control study of lung cancer deaths in the Flat River area concluded that smoking was the strongest risk factor contributing to the excessive number of lung cancer deaths. The study revealed that smokers had more than 30 times the risk of lung cancer than did non-smokers. It also found that underground miners had approximately a three-fold increased risk of lung cancer as compared to non-miners. Data were also obtained from birth certificates that indicated a greater percentage of mothers in the Flat River area smoke, and they smoke significantly more cigarettes than other mothers in St. Francois county or in the state as a whole.

For the Preliminary Public Health Assessment the zip code 63601 for the city of Desloge, which includes the cities of Elvins, Ester, Flat River, Leadington, and Rivermines was used as the geographic area of interest.

Cancer deaths by type of cancer, age group, sex, and total observed cancers were compared to the expected state rate for the years 1980 to 1990. In the analysis of deaths by type of cancer, we noted that combined male and female lung cancer deaths were significantly higher than expected for the 15-44 and 45-64 age groups. Males consistently had a significantly higher-than-expected lung cancer death rate in those groups, and in the 65-and-older group. In the 65-and-older age group, oral and liver cancer deaths were also significantly higher-than-expected when both sexes were combined, and oral cancer deaths were significantly higher when only males were considered. For females only, the 65-and-older group was significantly higher than expected for thyroid cancers, but the numbers were small (2.0 versus 0.3) and may not be meaningful because such findings may occur by coincidence. Females also had a significantly higher-than-expected number of

leukemia deaths when all age groups were combined, with ten deaths observed, versus 5.4 expected deaths.

Total deaths (male and female and all age groups) from lung cancer were significantly higher than expected, with 118 deaths observed, compared to an expected number of 90.1. Combined male and female cancer deaths for all types of cancer in the 65-and-older groups were significantly higher-than-expected, with 240 versus 204.6. Total cancers (all types) observed for all age groups and both sexes were significantly higher-than-expected, with 354 versus 308.4.

Cancer incidence for the zip code 63601 was compared to nation-wide data from the National Cancer Institute SEER program for cancer registry data for the years 1985 through 1991. Lung cancer incidences were elevated for the age groups 45-64, and 65-and-older in males, and the age group of 45-64 for females. The total for both sexes indicated only the 45-64 age group to be elevated. Other types of cancer showing an elevated incidence rate were liver cancer in the male 65-and-older age group. In females, cervix-uteri showed elevated incidence in the 65-and-older age group, non-Hodgkins in the 65-and-older age group, and other cancers in the 45-65 age group. The total for both sexes indicated an increased incidence only in lung cancer in the 45-64 age group, and non-Hodgkins in the 65-and-older age group.

Of continuing concern is the consistent, significantly higher-than-expected number of male lung cancer deaths for all age groups except the zero-to-14 age group. Also of concern is the total number of lung cancer deaths for both sexes of all age groups, and the total of all types of cancer for all age groups and both sexes, compared to the expected state rate. Lung cancer incidence rates were also high for males in the 45-64 and 65-and-older age groups, and for the female 45-64 age group.

For 16 employees and residents (15 adults, 1 child) of the St. Joe State Park area, which contains the Federal tailings pile, who would have varying degrees of exposure to the tailings, blood-lead levels were analyzed to determine if they were being affected by exposure to the tailings. Of the 16 tested, two adults had blood-lead levels above five μg/dL, at 10 and 12 μg/dL. Follow-up tests on these two individuals included a resampling of the blood-lead and a questionnaire to determine other possible routes of exposure to lead. The second blood-lead sampling yielded results of 10 μg/dL for the person measuring 10 before and 17 μg/dL for the person who previously had a measurement of 12 μg/dL. Results from the questionnaires suggested other possible routes of exposure.

We reviewed available statistical data on birth outcomes for the years 1980 through 1991. The fetal deaths, birth defects, and low birth weights occurring in the area were not significantly different from those predicted by the state rates.

C. Community Health Concerns Evaluation

Community health concerns are being addressed through the on-going interactions with the Citizens Advisory Group, interactions with community members through the current health study, and through interactions with local officials. Concerns gathered during the public comment release of this document are addressed in *Appendix C*.

PRELIMINARY PUBLIC HEALTH ASSESSMENT

BIG RIVER MINE TAILINGS DESLOGE
(a/k/a ST. JOE MINERALS)
DESLOGE, ST. FRANCOIS COUNTY, MISSOURI

CONCLUSIONS

DOH/ATSDR concludes, based on a review of available information, that the Big River Mine Tailings/St. Joe Minerals site is a public health hazard because of long-term exposure to various metals. Past mining in the area has left waste material (tailings) at many locations throughout the region, most of which are easily accessible to humans. Some of the heavy metals were not recovered in the milling process and were left in the tailings. Exposure to the elements (i.e. wind, rain, freezing, thawing, etc.) has allowed the heavy metals to become available to the environment and to humans. Wind, rain, and human use have helped distribute the tailings and heavy metals to the nearby communities and environment. Metals recommended for further evaluation are lead, cadmium, arsenic, and zinc. Those metals can be found at elevated levels in the tailings, soil, air, indoor dust, surface water, and groundwater on site and throughout the surrounding communities.

1. Lung cancer death rates and lung cancer incidence rates, especially for older males, are elevated in the area. Smoking was reported to be heavy in the area and may contribute to the elevated rates of lung cancer. Measurable levels of carcinogens, such as arsenic and cadmium have been detected in on- and off-site ambient air monitoring, above their CREG reference levels. Winds have been reported to spread a plume of mine tailings dust for approximately one mile around the area.

2. Total lead has been found in residential surface soils at elevated levels. Levels of cadmium, zinc, and arsenic were also found above the ATSDR's reference level. Blood lead levels in children living in the area are currently being evaluated.

3. Elevated levels of metals were found in concentrated household dust samples from nearby homes. The method used to collect the dust is not appropriate for quantifying levels of contaminants in the indoor dust.

4. Degradation of the Big River has been caused by releases of metal-contaminated tailings into the river. Elevated levels of lead, cadmium, arsenic, and zinc have been found in surface water and aquatic biota. Lead levels in fish and other food items, water, etc., may contribute to the lead intake of people who consume them. Surface water with elevated metal levels is not expected to be of concern unless the water is used as a drinking water source.

5. Groundwater from a few private wells within a one-mile radius of the site has been found to contain lead as a contaminant. A portion of the samples exceed the EPA Action Level for lead, which is used as a guideline for public drinking water supplies and is measured at the tap.

RECOMMENDATIONS

1. Evaluate the incidence and prevalence of lung cancer, particularly in adults. The evaluation should control for smoking.

2. Eliminate the spread of dust from the tailings.

3. Conduct an exposure study on children (6 to 72 months of age), pregnant women, and women of child

bearing age to determine actual blood-lead levels because of the elevated levels of lead that are readily available in various environmental media.

4. Consider determining the actual levels of lead in homes and its contribution to blood-lead levels. In order to better evaluate the availability of metals to humans, determine metal species (chemical form of the metal). Metal speciation may help determine the source of the contaminant (soil/tailings vs lead paint) and the direction of needed remediation.

5. Continue efforts to prevent releases from the Desloge tailings pile, as well as other piles in the region, and expand efforts to prevent continued loss of tailings into the Big River and it's tributaries.

6. Continue fish and biota sampling in the Big River to monitor the levels of contaminants. If lead levels continue to be elevated above a health concern, continue the advisory on not eating contaminated fish and expand notification efforts.

7. Continue groundwater monitoring to detect any movement of contaminants toward private wells.

8. Continue to distribute well sampling reports to well owners, along with recommendations on how to prevent exposure. This may include providing information about filtering systems.

9. Conduct health education activities for both the people in the community and area health care providers.

HEALTH ACTIVITIES RECOMMENDATION PANEL (HARP) RECOMMENDATIONS

The data and information developed in the Big River Mine Tailings/St. Joe Minerals Preliminary Public Health Assessment have been evaluated for appropriate follow-up health actions. The ATSDR Health Activities Recommendation Panel (HARP) determined that people are being exposed to contaminants from the site at levels that can cause illness. HARP determined that exposure to contaminants is caused from regional mining practices and not confined only to site contaminants. HARP determined that education is needed to inform the local community and health professional about how exposures can be reduced, as well as about health effects that might result from exposure. HARP also determined that the planned health consultation would help identify the exposed population. Once the exposed population is identified, a cluster investigation is indicated to determine if the increased cancer rate may be associated with exposure to contaminants from the site and others like it, or if the excess of cancers are a result of other factors, such as smoking, or a combination of several factors. ATSDR will reevaluate this site for additional follow-up public health actions if new data become available indicating a need to do so.

PUBLIC HEALTH ACTIONS

The Public Health Action Plan (PHAP) for the Big River Mine Tailings/St. Joe Minerals site contains a description of actions to be taken by ATSDR and/or DOH at and in the vicinity of the site subsequent to the completion of this public health assessment. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent human health effects resulting from exposure to hazardous substances in the environment. The public health actions to be implemented by ATSDR/DOH are as follows:

As previously stated, a number of activities have been started since the initiation of this document. To the extent possible, up-to-date information is provided. However, not all activities have been adequately defined and identified in this document. Further documents will be made available that will record the history of activities conducted until all work at the site is complete. The first of these documents is scheduled to be

initiated in late 1996.

Actions Implemented:

1. DOH is now conducting an ATSDR funded exposure study to determine if there are elevated blood-leads in the communities most affected by the tailings.

2. Public and Professional health education is on-going. Area health care providers have been given information on treating people with high lead exposure and on how to gather and evaluate patient information to determine the extent of exposure. DOH and ATSDR meet regularly with the Citizens Advisory Group about, among other issues, how to reduce or eliminate exposure to lead.

3. EPA has initiated removal activities and is moving forward with the Remedial Investigation/Feasibility study.

4. DOH and ATSDR are coordinating activities with EPA, local health officials, and the community in addressing the public health issues at the site.

Actions Planned:

1. Further community and medical professionals health education is expected to be implemented in the fall of 1996.

2. DOH, in cooperation with ATSDR, will evaluate new information and provide a summary of activities undertaken to date. The first of those evaluations will begin in late 1996 and will be made available for review upon completion.

3. The PHAP will be expanded if new information shows a need to do so.

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CERTIFICATION

The Big River Mine Tailing/St. Joe Mineral Public Health Assessment was prepared by the Missouri Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

Gail D. Godfrey
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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Richard Gillig
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PRELIMINARY PUBLIC HEALTH ASSESSMENT

BIG RIVER MINE TAILINGS DESLOGE
(a/k/a ST. JOE MINERALS)
DESLOGE, ST. FRANCOIS COUNTY, MISSOURI

Appendix A: Figures

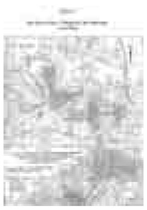
Figure 1: Site Location - Big River Mine Tailings - Desloge


Figure 2: Site Location - Big River Mine Tailings - Desloge and Other Major Tailings Pile Locations

Appendix B: Tables

Table 1

Summary and Range of On-Site Trailings Samples
Big River Mine Tailings/St. Joe Minerals Site

levels in ppm

Year of Sample	Lead	Cadmium	Zinc	Cobalt	Nickel	Arsenic
1980 (74 samples)	826 - 6,200 mean 2,077	6.8 - 78.6 mean 26	233 - 3,990 mean 1,226	NA	NA	NA
1988 (10 samples)	880 - 1,440	8.4 - 19	370 - 1,100	9.8 - 18	6.9 - 17	ND
1990 (14 samples)	910 - 13,000 mean 2,215 Surface & Subsurface	8.4 - 79 mean 21.7	370 - 4,300 mean 1,044	ND - 42 mean 15.4	ND - 37 mean 15.8	ND - 14 mean 7.6
1992	25 - 5,360	-	-	NA	NA	-
Background	64 - 76	ND	35 - 67	12 - 16	ND	6.2 - 9.5
Comparison value & reference	-	1 EMEG (pica child)	600 RMEG (pica child)	-	-	0.4 CREG

ppm = parts per million ND = Not Detected - = Not available NA = Not Analyzed

Table 2

levels in ppb

Summary and Range of On-Site Metals in Groundwater
Big River Mine Tailings/St. Joe Minerals Site

		Arsenic	Cadmium	Cobalt	Lead	Nickel	Zinc
1991 Monitoring wells	T	ND	ND - 7.9	13.7 - 16.7	16.6 - 617	ND - 46.5	60.2 - 705
	D	ND	ND	ND - 12.8	ND - 28.9	ND - 32.9	69.4 - 416
1990 Monitoring wells	T	25 - 110	ND - 37	ND - 350	23 - 9,300	ND - 680	26 - 850
	D	ND - 37	ND - 27	ND - 360	ND - 60	ND - 620	ND - 23,000
1990 Springs	T	ND - 21	ND - 190	ND - 85	36 - 14,000	ND - 92	98 - 9,100
	D	ND	ND	ND	20 - 33	ND - 60	27 - 1,900
1990 Geo-probe Temporary Well	T	14 - 85	ND - 30	53 - 170	1,700 - 10,000	60 - 170	470 - 2,500
	D	ND - 51	ND	ND - 55	ND - 74	ND - 43	ND - 450
1990	T	ND	ND	400	330	310	8,900

Leachate	D	ND	ND	400	29	320	6,400
1990 Landfill Drinking Water Well	T D	ND ND	ND ND	ND ND	17 14	ND 43	140 140
Comparison Value & Reference		0.02 CREG	7 EMEG (child)	-	15 EPA Action Level*	100 LTHA	2,000 LTHA

ppb = parts per billion ND = Not Detected T - Total D = Dissolved - = Not Available
* = Applies to drinking water sample only

Table 3

levels in ppm

Off-Site Tailings Piles Metal Concentration Summary
Big River Mine Tailings/St. Joe Minerals Site

1980 Samples	Lead	Cadmium	Zinc	Copper
National Pile (93 samples)	1640 - 9283 mean 3,508	2 - 87 mean 7.2	81 - 5,055 mean 457	51 - 628 mean 183
Elvins Pile (91 samples)	851 - 11,600 mean 4,392	19.8 - 202 mean 103	108 - 11,900 mean 5,482	-
Leadwood Pile (98 samples)	597 - 17,000 mean 2,444	9.3 - 1,870 mean 267	633 - 25,800 mean 5,009	-
Bonne Terre Pile (88 samples)	1,300 - 7,000 mean 3,515	3 - 29.5 mean 13.9	51.3 - 967 mean 541	-
Federal Pile 1991 MDNR	580 - 2,830	-	-	-
Comparison value and Reference	-	1 EMEG (pica child)	600 RMEG (pica child)	-
On-Site Levels for comparison (Big River Mine Tailings/St. Joe Minerals. Desloge)	25 - 13,000	6.8 - 79	35 - 4,300	-

ppm = parts per million - = Not Available

Table 4

Summary of Metals Levels from DOH 1985-86 Study
of Indoor Home Dust Samples from Vacuum Cleaners
Flat River-Desloge Area,
Big River Mine Tailings/St. Joe Minerals Site

all levels in ppm

Low	High	Average

Arsenic	1.2	13.2	5.75
Cadmium	1	31	13
Chromium	8	65 (with a single sample at 220)	21
Cobalt	ND (<5)	130	12
Lead	100	5,280 (with a single sample at 27,460)	1,099
Manganese	95	2,460	830
Nickel	6	133	42
Zinc	160	1,820 (with a single sample at 3,550)	808

< = less than ppm = parts per million ND = non-detect

NOTE: No ATSDR comparison values are available for metals in indoor dust. An estimate of exposure cannot be determined from the available data, nor can it be determined whether a health threat exists. Data is presented for information only.

Table 5

Summary of 1982 U.S. F&WS Big River Water Quality Sampling Big River Mine Tailings/St. Joe Minerals Site

levels in ppb

Location	Water level	Lead		Cadmium		Zinc	
		D	T	D	T	D	T
Irondale (background)	L	5	5	1	1	ND	ND
	M	5	5	1	1	ND	ND
	H	5	5	1	1	ND	ND
Desloge	L	20	41	2	4	310	360
	M	10	85	1	1	60	110
	H	12	110	2	4	100	160
Washington State Park	L	9	91	ND	1	10	40
	M	ND	140	ND	ND	10	70
	H	21	680	ND	ND	-	220
Brown's Ford	L	5	43	1	1	20	30
	M	7	84	1	1	10	30
	H	26	440	1	1	50	170

Table 6

Summary of 1982 U.S. F&WS Big River Sediment Sampling Big River Mine Tailings/St. Joe Minerals Site

levels in ppm

Location	Lead	Cadmium	Zinc
Irondale (background)	49.6	1.62	64.9
Desloge	2,215.0	29.96	1,658.4
Washington S.P.	1,843.4	10.79	704.3
Brown's Ford	1,438.3	6.55	484.5

D = Dissolved T = Total ND = Not Detected ppm = parts per million ppb = parts per billion
Source: EPA 1991 L = Low M = Medium H = High

Table 7

Big River Surface Water Summary from EPA LSI 1991
Big River Mine Tailings/St. Joe Minerals Site

	Lead		Zinc	
	levels in ppb			
Sample Location	Total	Dissolved	Total	Dissolved
Big River Backgrounds Upstream of trailings drainage	ND	ND	ND - 74	ND
Leadwood tailings pile tributary	61	23	1,300	1,200
Big River above site	15	ND	44	ND
Big River along Desloge Tailings pile	28 - 34	ND - 4.8	74 - 120	41 - 100
Flat River Tributary that drains Federal tailings pile	32	16	120	130
Big River approx. 5 miles below site & 2.5 miles below Flat River confluence	49	9.5	130	100
Turkey Creek tributary that drains part of Bonne Terre	22	11	ND	ND

tailings pile				
Big River 15 miles downstream from site	49J	11J	70	39

ppb = parts per billion ND = Not Detected

J = Data reported but not valid by approved QA/QC procedures

Table 8

Summary of Metals in Sediment from EPA LSI 1991
Big River Mine Tailings/St. Joe Minerals Site

levels in ppm

Sample Location	Cadmium	Lead	Zinc
Big River Background Upstream from trailings drainage	ND	ND - 1.4	21J - 53J
Leadwood tailings pile tributary	140	10,000	6,500J
Big River above site	46	720	1,900J
Big River along Desloge Tailings pile	21 - 120	1,300 - 3,600	840J - 6,700
Flat River tributary that drains Federal tailings pile	18	3,500	970
Big River approx. 5 miles below site & 2.5 miles below Flat River confluence	14	1,200	1,000
Turkey Creek. tributary that drains part of Bonne Terre pile	37	8,700	1,500
Big River 15 miles downstream from site	ND	680	290

ppm = parts per million
J = Data reported but not valid by approved QA/QC procedures
ND = Not Detected

Table 9

Lead and Cadmium Levels in Big River Biota

Big River Mine Tailings/St. Joe Minerals Site

Lead Levels in Biota from 1982 U.S. F&WS Big River Study

levels in ppm

Location	**Crayfish**	**Mollusks** (mean)		**Fish** (mean)	
		Tissue	Shell	Redhorse	Catfish
Irondale (background)	1.4	2.16	0.76	0.02	0.06
Leadwood	-	174.5	11.6	-	-
Desloge	140	-	-	0.57	0.13
Washington State Park	130	245	15	0.43	12.0*
Brown's Ford	110	386.67	18.5	0.63	0.29

Cadmium Levles in Biota from 1982 U.S. F&WS Big River Study

levels in ppm

Location	Crayfish	**Mollusks** (mean)		**Fish** (mean)	
		Tissue	Shell	Redhorse	Catfish
Irondale (background)	0.42	0.47	0.11	0.01	0.06
Leadwood	-	35.5	0.51	-	-
Desloge	1.5	-	-	0.03	0.03
Washington State Park	1.2	19.67	0.30	0.43	0.34
Brown's Ford	1.3	32.67	0.70	0.01	0.02

- = Not Available ppm = parts per million * Single 25 year old catfish

Table 10

Big River Mine Tailings/St. Joe Minerals Exposure Pathways

Pathway Name	Exposure Pathway Elements						Type of Pathway
	Source	Environmental Medium	Point of Exposure	Route of Exposure	Receptor Population(s)	Time	
Ambient Air	Tailings Piles	Ambient Air	Ambient Air	Inhalation	Residents of the area	Past, Present, & Future	Completed

Indoor Dust	Tailings Piles	Indoor Air & Dust	Inside Homes	Inhalation. Ingestion	Residents of the area	Past, Present, & Future	Completed
Soil	Tailings Piles	Surface Soils	Residential Yards & Playgrounds	Ingestion, Inhalation	Residents of the area	Past, Present, & Future	Completed
Groundwater	Ground-water	Ground-water	Private wells	Ingestion	Private well users	Past, Present, & Future	Completed
Fish	Tailings piles	River	Residences or cookouts	Ingestion	Fisheaters	Past, Present, & Future	Completed

Appendix C: Comments and Responses on the Draft for Public Comment of Preliminary Public Health Assessment for Big River Mine Tailings/St. Joe Minerals

Comments and Responses on the Draft for Public Comment for the Preliminary Public Health Assessment for Big River Mine Tailings/St. Joe Minerals

1. The document is not easy to read. Conjecture is mixed with fact, leading to the unintentional incorporation of "scare factors" in the report.

We do try to write the public health assessments in a readable way. When dealing with technical information, we often fall short of that goal. Thank you for telling us that you had trouble understanding the document. We will make ATSDR aware of this and will encourage development of a format that is more understandable.

We are not sure what you consider "scare factors." The information provided is accurate and is current as to our knowledge of toxicology today. Our intent is to inform people of how they are exposed to contaminants with the hope that they will take precautions to reduce their exposure.

2. It is very important to consider the species of metal-bearing minerals and how readily metals are released into the environment.

Mineral speciation is important to assessing what impact the Big River Mine Tailings site is having on local residents' health. However, recent studies conducted by EPA Region VIII show there may be many different lead species found in mine tailings, and that probably all lead species can be absorbed by the human body (bioavailable) to some degree. While it may be less bioavailable than other lead species, galena still can enter and affect the human body. We currently are in the process of doing an exposure study on blood-lead levels in children to determine the bioavailability of the tailings in the area. We also understand that EPA may have plans to conduct speciation testing along with environmental testing for the blood-lead study.

3. Speciation should have been evaluated during the assessment and before the report was written.

One of the purposes of the public health assessment is to identify data gaps and to make recommendations to fill that gap. The recommendation is made in this document to perform speciation; however, recent studies by EPA indicate that all forms of lead are, to some degree, bioavailable. Realistically, when deciding on how to remediate contamination such as that of the mine

tailings in the area, EPA will be evaluating many options. One of those options may be to convert the lead to the least bioavailable form. That action, coupled with the on-going community education activities that are underway, may pose the best solution for this problem. We are working closely with EPA to evaluate the feasibility of phosphate treatment as a method of addressing widespread metal contamination in combination with community health education.

4. If lead is so toxic, why don't we see Suckers and other bottom fish dead and floating in the Big River?

While lead has been well-proven as a toxin, both to humans and to animals, exposures usually do not cause immediate (acute) affects such as death except at extremely high doses. Effects are long-term (chronic) because lead accumulates in the body, and effects are not usually physically obvious. Lead exposure can have very serious effects on humans and animals.

5. In regard to Recommendation 3, I think resources could be better used for other studies, such as the lung cancer study, water sampling, etc. Exposure to large amounts of lead sulfide does not elevate blood-lead levels. Why spend money on this aspect when we know lead sulfide does not contribute lead to the bloodstream?

Contrary to current belief, lead sulfide is bioavailable and is a health threat. It is true that this species of lead is not as toxic as others and takes more to produce health effects, but recent research shows that lead sulfide does enter and can harm the body. Our mandate is to protect public health, and we feel this study will contribute information that we need to advise affected people and yet unaffected people in the area.

6. Also, is a sucker with 1 ppm lead a health risk if some fruits and vegetables have several ppm lead? Is the fish advisory really necessary?

Our goal is to reduce lead exposure to the extent possible. The fish advisory is one of the ways we can alert people and, hopefully, reduce exposure to lead by eliminating consumption of contaminated fish.

7. I was born and raised in the Old Lead Belt and moved to the New Lead Belt in 1973. I have constantly been exposed to wind-blown tailings and water "contaminated" by the heavy metals, both as a result of the mining activity and by the naturally occurring mineralization. I have been employed by a mining company for more than 25 years and have worked in the mines and mills of the Old and New Lead belts. Because of this constant exposure, I should have a much higher blood-lead level than the average citizen of the Old Lead Belt. But my most recent blood test showed less than 5 micrograms per deciliter of blood, measured in December 1993.

The blood-lead level is only a snapshot of a person's lead exposure. Lead does not stay in the bloodstream for very long, especially in adults. The lead leaves the blood and is stored in bone, so a blood test only shows lead levels at the time of testing and may not indicate elevated lead levels if time has past since exposure. We are glad that you feel that lead has not impacted your health. However, we also feel that you should share the conditions of your exposure with your health care provider so that person can monitor your blood pressure and other, less obvious effects.

8. If, after all of the studies that have been completed regarding the toxic hazard of lead it can still only be a possibility, then it would appear time to move on to another project.

We appreciate your opinion even though we disagree. Information that we gather now will help people in your community and will also help others experiencing similar exposures.

9. My uncle is, at present, 88 years old and still as sharp as most young men--and he worked in the lead industry for over 49 years. He started when he was 15 years old. So, really, there's not much of a health hazard here.

We are glad that your uncle is in good health. However, one person who apparently has not suffered ill effects cannot be used to predict how exposure may affect others. We have to examine a larger population that includes people that could be much more sensitive to toxic effects than others. Our public health guidelines are meant to protect all people, including those that may be more sensitive.

10. When there is lead in the ground and you drill a well through it, you are going to have lead in your well. But it hasn't killed anyone.

If a well is drilled and cased properly, lead that is bound to soil will not necessarily be in the water at levels detected by normal analytical procedures. Our concern is water or other environmental media such as air that contains lead at levels that will increase your body burden if you are exposed. We realize that everyone will be exposed to lead that is in the environment, but we need to minimize exposures when possible. As stated before, lead exposure will not cause death unless the dose is extremely high; lead's health effects are much more subtle, not usually physically observable, and result in problems that can affect the welfare of others who are not exposed (such as with the affected child who disrupts the class or is violent toward playmates).

11. What long-term [health] effects can we look for?

Exposure to lead can have a wide variety of health effects. While it may not seem to be a serious problem for one or a few people, it could be a very severe problem for a large population exposed to lead over a long period of time. We have mentioned high blood pressure (middle-aged men) and lowered I.Q. levels in children. Lead can also cause behavioral problems in children and youth. It could be as subtle as a child's being unable to get along with other people, exhibiting aggressive or violent behavior, or the inability for the child to communicate properly with others.

12. Although we have only lived here for a short time, just how much time must be spent in close proximity before an effect is felt by the people--the small children, the aged, and the adult? I have two very allergic children, allergic also to inhalants. Should I be more of a watchdog over their outdoor activities? How much of these toxins are we ingesting from our water supply or vegetables grown in this area and cattle raised here?

First, we want to emphasize that with simple precautions, many of which you likely already do, children should be allowed to enjoy themselves and not be afraid to play. Fortunately, exposure to lead can be greatly reduced by adopting some very simple habits. These include keeping children from playing on the tailings piles and in the dust, washing hands before meals and snacks, washing play-clothes after children have been outside, bathing before going to bed, wiping feet before entering the house, keeping the house as dust-free as possible, keeping toys clean and washing baby pacifiers after they have been dropped, and washing home-grown fruits and vegetables before eating.

Lead is a cumulative toxin. The amount of lead that enters that body determines what kinds of effects may be experienced. Effects may never occur or may be so subtle they are never noticed. If you have lived in the area for a short time, you and your children have not likely been exposed to enough lead to be of great threat. Unborn children and very young children are most sensitive. An expectant mother and infants and toddlers should avoid lead exposure as much as possible. The safeguards discussed in the previous paragraph will help minimize exposure to older children and adults.

To our knowledge, there is no documentation on allergic reaction to lead. However, people suffering from allergies may have reactions from the tailings dust, but this would not be related to the dust's lead content.

13. It is about time someone checked into this, as many feel it is a big problem. I feel someone should take a survey to see the increase of cancer in this area. I know cancer is a major concern of everyone.

We have reviewed available health outcome data, and a documented high amount of lung cancers exist in this area. Lead, however, has not been shown to cause lung cancer. Lead acetate is the only species documented to cause cancer in the laboratory animals. Cadmium and arsenic, heavy metals also found in the tailings material, are associated with cancer. Cadmium is a documented carcinogen through the inhalation route of exposure. This health assessment does recommend that further studies be conducted to determine the cause(s) of increased lung cancer. These studies would have to consider the documented increased smoking rate, along with many other variables, in order to determine what, if any, contribution cadmium or arsenic exposure contributes to the cancer rate.

14. There seems to be so many more people having migraine headaches. It used to be fairly uncommon--now it's almost as common as the cancer problem. Coincidence? I don't think it really is.

DOH appreciates this person's input and suggestion. Current data do not indicate that migraine headaches are caused by exposure to lead or cadmium. DOH has noted this concern and will keep it in mind as further studies and activities are performed at this site. As with any ongoing or serious health condition, DOH recommends that affected persons see their physician for diagnosis and treatment.

15. Stop this unneeded health study.

Thank you for your opinion. We disagree and feel we would be neglecting our duty as thestate's public health agency to stop the study.

16. Two years after moving to this area my lungs began to deteriorate to the point that I cannot cough up excess drainage like I could before moving here. I suspect it is due to the chat dumps. Many other people have told me they or family members have the same problem. Other people and I have been told unofficially by doctors that our lung problems are caused by the chat piles. I believe there is a health problem here, and I believe it is costing me my breath.

We strongly recommend that you and others having chronic health problems see a physician for a complete examination, diagnosis, and prescription for treatment. While the tailings piles do create a large amount of air-borne dust during dry, windy conditions, studies done to date have not confirmed that the tailings material is the cause of specific respiratory problems. You should not wait until studies on tailings piles are complete before you see a health care provider about your health problems.

17. My greatest concerns are the lack of knowledge of the mineral species containing the metals of concern, and the lack of understanding of how readily metals are liberated from the minerals into the environment.

We agree that more information is needed on the speciation and bioavailability of the contaminants and have made those recommendations.

18. The word "dolostone" should replace the word limestone, as the ore is hosted by dolostone.

ATSDR's Public Health Assessments are written for the affected community. Limestone is the word most commonly used by the general population for the material and is the word of choice for the public health assessment.

19. I question the findings of HARP and others who claim the metal concentration of the tailings is sufficient to pose a toxicity threat. They did not consider mineral species and solubility. Health evaluations regarding metals should consider the form of the metal.

We believe the HARP determinations were accurate and appropriate. We do agree that more information on the metals would enable us to provide better advise regarding exposure; we made that recommendation.

20. Both pyrite and marcasite should be searched for and analyzed for arsenic. If these minerals do not contain arsenic, it may be coming from sources other than the tailings.

Arsenic has been detected in the tailings, and exposure to the arsenic, regardless of the source, is of concern to us. It is not within the scope of the public health assessment to determine the source of this contaminant.

22. The mean value of lead in agricultural soils from around the country is 12 to 50 ppm. Some fruits and vegetables contain mean values of up to 12 ppm lead. Why should groundwater have 0 ppb lead when it is a naturally occurring, widespread element?

Notwithstanding the mean value of lead in soil, fruit, and vegetables nationwide, the 0 ppb of lead in water is a goal. EPA's action level for lead is 15 ppb, so it is unlikely that anything would be done about water with lead levels below that. Our goal is to eliminate exposure to lead and other toxic chemicals whenever possible. We realize that we cannot prevent all exposure to naturally occurring elements.

23. DOH could contact those studying tailings mineralogy for a better understanding of cadmium mobility. Perhaps DOH should evaluate this aspect before establishing a blood sampling program. You may want to drop the program if cadmium is not available as a free-metal, or you may want to modify sampling and analytical technique if cadmium is still considered a potential hazard.

DOH appreciates these comments and suggestions. However, we believe that, instead of waiting for an environmental study, which could take a long time to complete, the best interest of people's health is served by seeing if people are being exposed. If people are taking up the contaminants, we can propose actions to stop or lower their exposures and offer advise to local health care providers on how to monitor the health of those exposed.

24. With the many real problems facing our state and nation, spending enormous sums on a perceived problem without any real benefit would be absurd. I see no reason at all for initiating a huge Superfund dollar demand.

DOH and ATSDR believe that when it comes to protecting the lives and health of people, especially children, the benefits far outweigh the costs.

25. I suggest that generating concern over the health threats of these old tailings is unnecessary and uncalled for. The threat of small amounts of lead residue in these old tailings has been grossly overstated.

We strongly disagree with this statement. The amounts of lead in the mine tailings are far from small, and the hazards of being exposed to contaminants in the tailings have not been overstated. We do not want to frighten people, but we do want local residents to know that their health could be adversely affected by exposure to those contaminants. It is true that we do not yet know exactly what levels of exposure have occurred or what health effects we may see as a result of such exposure. We do intend to take appropriate actions based on our study findings.

26. It is obvious that the tailings are gradually weathering and healing.

This statement contradicts itself. It is true that the tailings are "weathering." But in this case the weather (wind, rain, and time) are breaking the tailings down into smaller particles. This is not a process of healing or getting better; it is a case of decay and worsening. The smaller the tailings become, the more easily they can be moved into and through the environment, thus making them more available to human exposure through inhalation and ingestion.

27. There is an encroachment of vegetation along the edges and occasionally in the middle. This process

could be assisted by the simple expedient of permitting the scattering of waste tree tops, limbs, waste chips and clippings from power-line rights-of-way maintenance, and even old sawmill slabs. All of these reduce surface wind velocities and temperatures and trap dust particles from the air which eventually form a ground cover and assists in the natural start of new vegetative life.

These are good suggestions, though we do not believe that only vegetation efforts will be enough to reduce degradation and movement of the tailings to a safe level. Additional efforts may include capping the tailings piles with layers of various materials, with soil and vegetation on top.

28. Some simple vegetation-generating and support measures could be initiated which would improve both the appearance and the environmental quality of the area. I don't know as such action falls within the mandate of the Health Department.

See the previous statement and response. Further, it is true that it is not within DOH's mandate to initiate vegetation or capping action. However, we do make recommendations for actions that are protective of public health.

29. I wonder how much money has been spent on this--and now they want to spend $12 million more of the taxpayers' dollars for something that time has proven doesn't hurt a thing. If it does hurt somebody, show it to us in person. If the chat dumps are that bad, how do the people do so well in all walks of life?

All expenditures on this and all National Priorities List sites are part of public documents and available for public review. On the contrary, it has not been proven that local residents have not experienced adverse health effects from contaminants in the tailings piles. As we have previously stated, the effects of lead poisoning are not usually visible. When we complete our studies, we will have a better understanding of exposures we believe are occurring and can perhaps give you actual scenarios of what impact, if any, these exposures have had.

30. We do have a lot of dust and chat that blows in during very windy days. People even have chat in their homes and have no children to track it in. This really has been a problem for years.

DOH and ATSDR appreciate this person's input.

31. It is my considered judgement that branding the chat piles as "hazardous waste" is without merit, and the practice should cease. Rather, this material is a valuable resource and should be exploited. Finding new uses for the chat would be a better endeavor than the present fruitless activity.

The chat piles contain substances that are known to make people sick when those people are exposed to a certain level of the contaminants. For that reason, they are considered "hazardous waste." However, we may develop ways to stabilize the hazardous contaminants within the chat, and then find safe uses for the tailings material. Our intention is to be part of efforts to find effective uses for the materials.

32. Stabilize the Desloge chat pile area to prevent further losses of material to the Big River.

EPA is proposing to make great efforts to stabilize the Desloge pile and protect the Big River from further impact from the pile. Construction is underway.

33. Petition the Environmental Protection Agency to remove the Desloge chat pile from the Superfund list. Certainly there are more productive ways to spend money.

Your comment will be read by EPA. Thank you for taking the time to read the document and provide comment.

34. It is distressing that the inferences made and the conclusions drawn in the Health Assessment are flatly contradicted not only by numerous other EPA supervised health risk studies, but also by many of the studies upon which the Health Assessment itself is supposedly premised.

We are not aware of a risk assessment that has been completed for the site; therefore, we cannot verify that contradictions exist. Risk assessments and public health assessments are complimentary documents, not contradictory documents. Risk assessments are conducted in order for EPA to establish what needs to be done to the environment in order to protect public health and the environment. Public health assessments are conducted to identify whether people have been exposed to contaminants and what needs to be done for the exposed people. Because different end-points are needed, information is evaluated slightly differently.

35. As demonstrated by recent articles in the local press, the Health Assessment has had the effect of misleading the public and has wrongly heightened public concern over the Site without any scientifically significant factual basis. Rather than helping to educate the public about mine waste issues, the Health Assessment instead defeats meaningful public discourse; frustrates cooperation between industry and government over environmental issues; and potentially, encourages needless and wasteful litigation.

We do not feel that you expect a response to your comment because you are providing us with your opinion. We disagree with your opinion and feel the public should be provided with as much information as possible. Our opinion is that meaningful discussions can only occur when everyone has as much information on the subject matter as possible.

36. Environmental Protection Agency: Page 5, Paragraph 5; the text incorrectly states that the landfill operating at the site uses the mine tailings as a daily cover which is then capped by three feet of clay and vegetated. The clay cover material is actually spread to depth of three to six inches prior to establishing vegetative cover. The text should be revised accordingly.

The document has been revised.

37. Environmental Protection Agency: Page 15, Paragraph 1; It should be explained here that "J-coded" data as reported by a Contract Laboratory Program (CLP) lab are chemicals whose concentration occurs above the CAP contract reportable concentration limits for Quality Assurance/Quality Control (QA/QC). Thus, J-coded data are useful for site characterization purposes, but have limited value for enforcement proceedings, because they represent an estimated value above the contract reportable limit for meeting the contract QA/QC requirements.

The document has been revised.

38. Environmental Protection Agency: Page 40, Recommendations; Health recommendations to reduce exposure to contaminated soil and dust in residential settings near the site should be provided in this section.

This is a good idea, but we do not feel the public health assessment would have the circulation to reach a large enough portion of the population. Furthermore, the information could be buried in all the other information in the public health assessment. For those reasons, DOH will be doing community outreach and education to help lower exposure to the tailings. This information is available at the St. Francois County Health Department.

39. Environmental Protection Agency: Page 39, Last Paragraph; The text should reflect that the EPA Action Level for lead was established for public water supplies and does not specifically relate to private wells.

This information has been added to the text.

40. Environmental Protection Agency: Page 39, Paragraph 4; EPA has released for public comment an Engineering Evaluation/Cost Analysis for early actions at the site. These actions will stabilize wind and surface water erosion of the Big River Tailings pile. EPA will decide what specific action will take place following the public comment period.

That information has been added to the *Actions Implemented During Health Assessment Process* section.

41. Environmental Protection Agency: Page 39, Paragraph 5; Well sampling results will be distributed to well owners, including information on reducing lead exposure.

This is just a recommendation. We realize that EPA reports the results of well testing to well owners and did not intend to insinuate otherwise.

42. Environmental Protection Agency: Page 39, General; EPA will be conducting a Remedial lnvestigation/Feasibility Study (RI/FS) in addition to the early actions at the pile. The RI/FS will evaluate the extent of contamination, risk assessment, and the need for additional work beyond stabilizing the erosional potential of the tailings pile.

This information will be added to the *Actions Implemented During Health Assessment Process* section.

Comments from Dames & Moore, Consultants for St. Joe Minerals

GENERAL COMMENTS

1. The Missouri Department of Health (DOH) and ATSDR's Preliminary Public Health Assessment for the Big River Mine Tailings/St. Joe Minerals Site inappropriately draws quantitative health conclusions based on minimal health and environmental data that are neither completely revealed nor shown to meet standard data usage criteria. The report should not attempt to draw quantitative conclusions about potential health threats associated with exposure to site-related metals.

Public Health Assessments are designed to present information, derived through quantitative evaluation, in a qualitative format that the general public can understand. The quantitative aspects of our work primarily involve dose estimations when possible in order to evaluate possible health outcomes and a statistical analyses of health outcome data. Dose estimates are based on worst-case scenarios. Health outcome data evaluations follow standard epidimiology practices. These quantitative evaluations are appropriate and necessary. The methods we use do not always coincide with risk assessment techniques because our end-point is not the same as a risk assessment's. The two processes are, however, complimentary in nature.

2. The health assessment alludes to the need for a cluster investigation study for lung cancer. This investigation is likely to be ineffective, since such a study has already been performed, the results of which indicate the increased lung cancer rates are attributable to cigarette smoking. [In the assessment], the text states, "The Missouri DOH 1985-86 case-control study of lung cancer deaths in the Flat River area concluded that smoking was the strongest risk factor contributing to the excessive number of lung cancer deaths." Stating later that the "high" lung cancer rate in the same paragraph may be attributable to site-specific heavy metals when there is [sic] no data to support this conclusion is a concern. In fact, existing data clearly indicate smoking as the main causal factor. It is an inappropriate juxtaposition to commingle a discussion of higher than normal rates of lung cancer undoubtedly attributable to increased smoking rates (implying that one is causally related to the other or at least associated with the other) when no evidence is presented to support an association between mining materials and cancer

rates.

The previous study was not designed to determine whether exposure to the tailings waste could be a contributing or primary factor. What we do know is that smoking is a big factor in either directly causing lung cancers or putting people at greater risk when exposed to other known carcinogens.

3. If EMEGS and CREGs are used in this assessment as health-based criteria, include information on the derivation of these criteria. Also, the text does not explain why different reference criteria were used for the various metals evaluated in an environmental media. For example, in Table 2, a CREG was used for arsenic, an EMEG for cadmium, an MCLG for lead, and LTHAs for nickel and zinc. Since an MCL is available for arsenic and cadmium, include these values in Table 2. The document appears to incorporate the lowest possible reference values in spite of the availability of other, more widely recognized criteria.

EMEGS, CREGS, and other environmental comparison values are derived from toxicological information such as ATSDR Minimal Risk Levels, EPA Reference Doses, and EPA Cancer Slope Factors. They are not used to predict health outcomes; they are used only to select contaminants present in an environmental medium for further evaluation in exposure pathways. Different comparison values are used because health assessors select the most conservative comparison value (the lowest number). By doing that, we ensure that all contaminants that may be present in a completed exposure pathway are further evaluated for health implications. Contaminants that may be present, but at levels below our conservative comparison values, are not expected to cause any health problems, even under worst-case exposure scenarios.

4. Data are not presented to support the risk calculations performed. The selection of comparative values is overly conservative and the use of worst-case scenarios and ultra-conservative cancer risk calculations result in a risk assessment which cannot be realistically applied to any current receptor, on site or off site.

As a public health agency, our mandate is to protect all people, including those most sensitive, from any exposure that may cause harm. For that reason, we use very conservative methods when conducting our evaluations. Our goal is to determine what to do for exposed people. Risk assessment is performed differently because the endpoint is to make clean-up decisions that will protect public health. Risk assessments do not provide a mechanism for health follow-up of people that have already been exposed. The public health assessment process provides that mechanism.

5. The maps provided with the document do not adequately represent actual sampling locations. The maps do not show the landfill, drinking water wells, municipal wells, soil sample locations, aquatic sampling locations, etc.

The maps provided with the document were never intended to indicate sampling points, etc., but rather to aid the reader in visualizing the site, its location, and, as in Figure 2, how the tailings piles are located in relation to residential areas. Maps showing the detail you mention are more appropriate for in-depth environmental investigations and would add little to this document. We do want to emphasize that we study that type of information carefully when conducting our evaluations.

SPECIFIC COMMENTS

NOTE: Page numbers and paragraphs may be different in the finished document than those mentioned in the comments because changes have been incorporated into the final document as a result of the comments.

1. page 6, first full para: If the river's degradation was caused mainly by physical changes in the benthic

zone instead of chemical changes, then chronic impacts may not be of concern. The riverbed composition shifts during periods of high flow, and, eventually, conditions would return to pre-1977 conditions, providing the tailings are stabilized.

The key to this comment is "providing the tailings are stabilized." So far, stabilization of the tailings has not occurred, and the tailings pile still affects the river's fish and biota as determined in EPA's 1991 Final Report Listing Site Inspection Big River Mine Tailings. Runoff still occurs from the Big River pile and is also occurring from the other tailings piles in the area, which also contributes to the effects on the Big River.

2. page 6, para 4: The text states that according to a 1982 Fish and Wildlife Service report of the effects of tailings on the Big River, that "elevated residues of lead, cadmium, and zinc were found in every biological form examined." The text should specify what levels were measured in various biological forms and how the study determined that they were "elevated." For example, were they elevated relative to background or baseline levels? If so, what data were used as reference concentrations?

The detected levels for lead, cadmium, and zinc in water and sediment, along with backgrounds, are listed in Tables 5 and 6. Detected levels of lead and cadmium in aquatic biota are reported in Table 9. The referral to the tables was inadvertently left out of the text in the *Background* section, but was discussed in the text under *Off-Site Contamination* headings of Surface Water, Sediment, and Aquatic Biota with referral to the provided tables. A notation has also been added to Tables 5, 6, and 9 denoting the background site for clarification. *Aquatic Biota* has been added to the heading under the *Off-Site Contamination* section for inclusiveness.

3. page 11, para 3: The statement "Giggers took more sucker species and carp on the Big River than on the other two rivers surveyed" implies that the species diversity of suckers and carp is higher in the Big River as opposed to the other rivers surveyed. As written, the sentence does not provide meaningful information on the relative numbers of fish taken.

This statement was not intended to provide information on the relative numbers of fish taken on the three rivers surveyed. The statement is an indication that large numbers of carp and suckers were still being taken even though the fish advisory was in full effect and shows that people were being exposed to the contaminated fish. The number of fish taken per hour (4.95) was added to provide a relative number of fish being taken and consumed.

4. page 12, para 6: A summary of the 1985-86 case control study of lung cancer deaths in the Flat River area and adjoining communities is presented. The case control study was conducted using 1976 to 1984 statistical data. On page 40, it states that high smoking rates were associated with the study group and may explain the variable. This [sic] data on page 40 should be moved to this paragraph on page 12 so that it is clear to the reader that, in fact, the overwhelming likelihood of excess cancer is attributable to cigarette smoking. If the study is to be cited, it would be appropriate to present more than cursory summary information so that the reader can draw the conclusion, otherwise the implication is left throughout the report that site metals are an explanatory variable for the cancer rate, when in fact there are no data to substantiate this. A well-established explanatory variable (cigarette smoking) is clearly present.

The sources of the health outcome data are listed in the early section (page 12), and then evaluated and expanded in the *Health Outcome Data Evaluation* section.

The statement on high smoking rates is not appropriate information to include on page 12 because that information is intended only as a list of available data sources.

Note that the 1985-86 Cancer Case Control Study was done only in Flat River and nearby areas. The study findings allude to the presence of an increased rate of lung cancer but do not provide

information on the types of lung cancer identified. The study does indicate a three-fold increased rate of lung cancer in former miners.

We will amend the conclusion and all other references that may suggest we support a causal relationship between lung cancer and heavy metals from the 1985-86 cancer study. However we must emphasize that we do not believe a definite cause was established between increased smoking rates and increased cancer incidence. In any case, the question remains as to why males involved in past mining operations have an increased rate of lung cancer.

Substantial additional information/data have been developed about lead, cadmium, arsenic, and about smoking since the 1985-86 study. New data should be evaluated when addressing the health status of the people in communities surrounding the site. The fact that a study was conducted does not mean that all questions have been answered.

5. page 15-16, Ground water:

a. The discussion in the first paragraph under the groundwater heading is based on results for one drinking water well sample and several monitoring wells and springs in or peripheral to a landfill on the tailings pile. Combining the results for potable groundwater and the landfill groundwater is confusing. The confusion arises later in the paragraph where it is stated, "Only heavy metals were detected at levels of concern." This statement is unsupported and may improperly lead the reader to conclude that the appropriate level of concern has been applied correctly in the comparisons. Such a comparison is inappropriate in this type of document. The reader should be able to make an objective evaluation of the data used in these comparisons. Table 2 shows that results from the landfill groundwater sampling program were incorrectly combined with the drinking water well sample and that comparisons of measured levels of metals in groundwater were made to a mixture of drinking water standards from various regulatory agencies. Comparisons made on a mixture of standards is not accepted practice. Table 2 should be revised to include only results for drinking water samples (the landfill office well, Flat River Water District Public wells, and the private wells samples from the area) and should clearly identify whether the samples are tap or well water. Furthermore, MCLs should be listed in Table 2 for all metals for which they are available. An MCL of 50 μg/L is available for arsenic and 5 μg/l for cadmium. The Action Level for lead 15 μg/L should be used as a comparison values instead of the MCLG (zero) since groundwater discussions in this assessment on page 20 refer only to the Action Level. It is not appropriate to state that levels of cobalt measured in ground water samples "were detected at levels of concern," since there is no regulatory or health-based criteria for cobalt (OSWER 9360.1-02, 1993).

The discussion in this section and Table 2 is to indicate the level of contamination of groundwater on site. The landfill drinking water well is indeed on site and even though it is deeper than the other wells, may give an indication that it is also being affected by contaminants on the site. Table 2 clearly states the types of wells. Other comments regarding the use of comparison values and their derivation have already been discussed and that information does not need to be repeated.

Even though there is no ATSDR comparison value, MCL, or other health or regulatory value for cobalt, the levels of cobalt are elevated over what may be considered normal. In studies to determine the level of cobalt in water supplies, levels from 35 geographical areas ranged from 2.6 to 107 ppb with an average of 21 ppb. That was found in only 9.8% of the 3,834 grab samples. In another study, cobalt was not detected or was found up to 19 ppb, with the average being 2.2 ppb (ATSDR 1992c).

In the text, the two on-site monitoring wells were listed incorrectly as sampled for pesticides, volatile organics, base-neutral-acid, total metals, and dissolved metals in 1990. That has been corrected to read 1991 (E&E 1991), as the monitoring wells were only sampled for metals in 1990.

b. It is questionable if the results of the landfill water samples are pertinent since there is no exposure

pathway to a human receptor. If the landfill results were included to characterize metal content in the perched aquifer near the landfill, this discussion should be in a separate paragraph with supporting Hydrogeologic information characterizing the permeability, thickness, and extent of saturated units neighboring the landfill. The landfill water sample results should be compared to suitable background (upgradient) results to effectively demonstrate what metal(s), if any, are potentially attributable to sources within the landfill debris/tailings.

This discussion is intended to show the level of contamination in on-site groundwater and to determine by comparing them to ATSDR comparison values if the groundwater needs further evaluation. We cannot assume that on-site groundwater does not present an exposure pathway, especially since the landfill drinking water well may be affected by the site contaminants.

c. Claiming that "contaminants of concern are arsenic, cadmium, cobalt, lead, nickel, and zinc" is premature. While these six metals appear to be the parameters detected in groundwater, no information is provided to allow the reader to compare background concentrations near the landfill. Thus, the determination that the metals are contaminants of concern may be invalid. The metals should be considered contaminants of concern only if levels in potable ground water on-site are elevated relative to local background levels. Furthermore, the referenced statement is not true for the drinking water well, as five of the six listed metals were not detected in that well or were detected at concentrations below comparison values.

The statement that these six metals are of concern is from the Listing Site Inspection report on the Big River Mine Tailings (EPA 1991), where it states, "Metals of concern detected in groundwater samples include arsenic, cadmium, cobalt, lead, nickel, and zinc." Additionally, ATSDR uses the term "contaminants of concern" to indicate chemicals that are included for follow-up evaluation in exposure pathways. We do agree that the terminology can be confusing if the contaminants, after further evaluation, are only of environmental concern and not of health concern.

6. <u>page 16, On-Site Air</u>:

a. The total number of air samples analyzed should be indicated. For arsenic, the statement that three samples exceeded the CREG does not inform the reader what concentration of arsenic was measured or where these concentrations were measured. Results of the 1990 study should be tabulated in this report. Were the three samples collected at the landfill location or at the other on-site location?

The document has been revised to indicate the total number of air samples taken during the E&E/FIT investigation for the Listing Site Inspection Report. We have also included the levels and the locations of where the arsenic was detected. For a full report of the air sampling data, refer to the 1991 Final Report Listing Site Inspection.

b. Provide the NAAQS standard for lead of 1.5 μg/m3 per calendar quarter in lieu of an ATSDR comparative value, as presented in the off-site air discussion on page 19. The lack of an ATSDR comparative value does not justify ignoring other applicable standards.

We do not feel that the NAAQS number is an appropriate comparison value because the value is determined for sampling collected for an entire quarter. The sampling program was not designed to provide an average level of lead in the air at the site for a quarter. Lead in the air is important when evaluating multiple exposure pathways.

7. <u>page 16, para 3 (last)</u>: The report notes that ATSDR's CREG level for cadmium and arsenic is substantially less than the detection limit used in the study. This severe mismatch occurs not because the detection limit is inappropriate, rather this is because the CREGS are calculated in such a conservative manner. The end result is that when CREGS are used as "health-based criteria," and compared to reasonable analytic detection levels, a serious disparity occurs. The CREG is based on

sufficiently conservative assumptions that in reality arsenic and cadmium levels in air throughout a substantial portion of the United States would fail the criteria. Discuss this issue in more detail in the text so that the reader understands that these numbers are extremely conservative. Emphasize that CREGs are used as an overly protective screening criteria, and that levels exceeding a CREG does not imply that there is an attributable excess risk of cancer. As written, the document does not offer any data or calculations that support implications that exposure to metals in air near the site could cause excess cancer cased in exposed individuals. On page 34 of the document, the maximum measured value of cadmium is used in a screening calculation which leads to the inference that if individuals were exposed to the maximum cadmium level, this exposure could correspond to 16 excess cancers per million. To use such a calculation as evidence that the observed elevated cancer incidence in individuals living near the site may be due to exposure to site-related metals is unjustified.

CREGs are conservative comparison values. We added to the text that comparison values are conservative. The calculations were performed based on estimated doses and specific, conservative exposure scenarios. As with any "risk" calculation that computes to such low numbers, the "risk" may in reality be zero. However, because cadmium and arsenic are known to cause cancer under some conditions, we estimate a possible "risk" number and provide qualitative information to people who may particularly sensitive.

8. page 17, Soil Levels Off-Site: The text states that the highest levels of cadmium and zinc measured in surface soils from the nearest residence closest to tailings is 270 μg/kg and 13,000 mg/kg, respectively. We have conducted an independent screening calculation, assuming that an average child resident would conservatively ingest 200 mg soil/day, 350 days/5 years, for six years and weigh 15 kg, the chronic daily intake of cadmium and zinc would be 0.003 mg/kg-day and 0.2 mg/kg-day. The EPA oral RfD for these two metals is 0.001 and 0.3 mg/kg-day, respectively. The RfD represents the level of exposure not expected to cause adverse effects even in sensitive sub-populations. These data indicate that the maximum measured level of zinc in soil does not pose a health threat to individuals living near the site. Dose based on the maximum measured level of cadmium in soil exceeds the RfD by a factor of three. At the next closest residence, the maximum cadmium level in surface soil was 25 mg/kg. Using this measured value, the chronic daily intake is estimated to be 3 x 10-4 mg/kg-day, which is well below the oral RfD for cadmium.

The cited text is only reporting the levels that were detected in the 1990 LSI. Whether illness is expected to result from exposure to specific contaminants is discussed in the *Public Health Implications* section, *Toxicological Evaluation* subsection.

9. page 18, ATSDR reference levels:

a. The value listed for cadmium of 1 ppm based on a pica child EMEG is highly conservative and inconsistent with the available published literature on cadmium toxicity. In the most recent version of ATSDR's Toxicological Profiles for Cadmium, ATSDR has withdrawn the EMEG of 10 ppm. Furthermore, use of an EMEG based on pica behavior in children as the health-based criteria is not substantiated by medical evidence. Pica behavior is a medical condition not amenable to general soil remediation. (Harrisons's Principles of Internal Medicine, the Ed.). It is well-established in the pediatric literature that pica must be treated by first, a medical evaluation, and then secondary, specific dietary and behavioral modifications. Hence, there is no level of environmental cleanup that can be "protective" for a pica child. It is completely inappropriate to base a health standard on a reasonably uncommon condition that can only be evaluated and treated by medical intervention unrelated to soil concentrations of metals. If criteria based on pica behavior in children were routinely used as "standard," then a substantial portion of soil in the U.S. would require remediation.

b. The same argument applies to the EMEG for zinc, which is also based on a pica behavior in children. In addition, this document does not acknowledge that within the last six months, the EPA raised the

reference dose for zinc by 50 percent. A similar argument can be made for the arsenic CREG level of 0.4 ppm. Based on this level, a substantial portion of the naturally-occurring levels of arsenic in U.S. soils would require public health warnings and potential remediation. The numbers used in this assessment are inappropriate as a screen since they "screen" very little. Substantial urban and rural areas of the U.S. would not pass the ATSDR "screen." By setting the screen at an ultra-conservative level, it forces entire populations into a category requiring possible health evaluations. The inherent conservatism of the criteria used in this assessment should be clearly explained so the reader can make informal comparisons.

Again, the environmental comparison values are not used to evaluate health but are used only to select contaminants for further evaluation of any health implications should exposure occur at those levels. Likewise, the comparison values are not to be used, nor do we suggest their use, for clean-up levels. We do feel that scenarios involving pica children are appropriate for certain conditions, especially if contaminants could be brought into households where very young children crawl on floors.

10. page 18, Indoor Dust Section:

a. Please provide from the 1985-1986 study a brief description of what the vacuum bag samples contained. Did they contain dust, dirt tracked in by residents or pets, human or pet hair, vegetation, visible tailings, miscellaneous mater? The term dust defines inhalable particulate, i.e., particles 10 μm or less in size that can be re-suspended and inhaled. The measured concentrations of dust can be used in human health risk assessment for estimation of exposure to particulate phase chemicals. From appearances, the results from the vacuum samples do not constitute a viable substitute for actual indoor dust sampling, as is implied here and in the remainder of the document. This bias is acknowledged with the statement that one sample contained miscellaneous material which caused extreme bias in lead concentration. The vacuum sampling methodology violates an important QA/QC consideration for risk assessments, that "the collected samples are representative of the situation due to site conditions, not conditions posed by the sampling equipment" (Risk Assessment Guidance for Superfund (RAGS), 1989, p. 4-22). Nonetheless, the document refers to the biased sample results as "indoor dust" samples throughout the assessment. The vacuum samples do not equate to indoor dust and the inference that they somehow are representative of the levels that residents may be exposed to while indoors is inappropriate. While the use of indoor dust sampling data is common, particularly for the assessment of lead exposures, the methodology employed in this particular study is flawed for use for health predictions. The use of vacuum samples overestimates realistic exposure point concentrations so they are not useful. All reference to "indoor dust samples" should be deleted and replaced with "vacuum bag" samples in this report and the section(s) on indoor dust that include, make reference to, and use the vacuum data should be deleted.

The document has been revised to say dust/dirt samples.

b. There are no data in this section indicating where the homes sampled are located (i.e., their distance from tailings piles or other sources of site-related metals). The reader must return to page 7 to find the study and what was done. The distance from tailings is important because a conclusion is later drawn on page 38 that "Metals associated with the tailings piles were found in concentrated dust samples from homes." As presently written, this conclusion is false since there is not a report of tailings identified in the vacuum bag samples, or an established physical tie between the residence and the tailings pile. Thus, this sentence should be stricken from the report as insupportable.

The intent of this statement is to say that similar metals have been found in the dust of homes in the area. At this point it is not possible to establish the source of these metals. Whether one or more sources are involved, as well as the percentage of contribution by the different sources, must still be established. We reworded the conclusion for clarity.

11. page 19-20, Off-Site Air:

a. The 50 μg/m3 TSP standard is not retroactive to 1981 as implied here. TSP is not a carcinogen and the statement that the 1991 standard "would have been exceeded in 1981" is inappropriate for this assessment. Currently, there is no federal standard for TSP.

The statement has been changed so that it does not imply that the TSP was retroactive.

b. The report should include a table showing the results of the 1990 LSI study. Since the arsenic and cadmium CREG is below the detection limits used by E&E in the 1990 LSI study, it cannot be determined if these two metals occur at above-CREG levels in the off-site or background non-detect samples. Were there sampling or laboratory problems that resulted in higher-than-normal arsenic detection limits or is the CREG arsenic level regularly achievable in the laboratory?

When laboratory problems occur, they are noted in the *Quality Assurance/Quality Control* section of the document. CREG levels are achievable in the laboratory for most chemicals. Testing at those levels is sometimes very expensive.

c. Are the reported metal concentrations in TSP or PM-10? PM-10 is typically used, if available, since it better approximates the inhaled fraction. If TSP results are used for exposure point concentrations, an overestimation of risk could result and this should be stated with the qualifiers.

The information in the referenced material lists the data as total suspended particulate (TSP) annual geometric mean for the years 1981 through 1983. Again, we are simply listing the data that have been accumulated on the site and area. For more information refer to the 1990 LSI.

12. <u>page 20-21, Ground water</u>:

a. EPA's replacement of the MCL for lead in groundwater should be referenced (USEPA Drinking Water Regulations and Health Advisories, May 1993) and clarification should be provided that the Action Level of 15 μg/L applies to tap water, not to groundwater in wells as the text implies. The Action Level should be cited in Table 2 as a comparative value for drinking water samples only.

The document has been referenced to indicate the USEPA Drinking Water Action Level of 15 μg/L and the statement clarified to indicate that the action level applies to public drinking systems. Since private drinking water wells have no enforceable standards, the action level for lead and MCLs are used as safe indicator numbers. Table 2 has also been revised to include the action level.

b. None of the available hydrogeologic information (USGS, Missouri Geologic Survey) is given characterizing the aquifer(s) which are tapped by public and private users. Is the aquifer sufficiently deep to derive recharge from areas distant from Desloge such that influence from local metal sources is not a problem? Do domestic supplies come from mine workings (as suggested by the Rivermines water district well) which could be affected by many surface or shallow metal sources? These questions needed to be addressed in the assessment. The focus of the public health assessment is the Big River mine tailings pile, but this discussion draws no conclusion as to the source of metals in the domestic water supply. Is the source tailings, unmined mineralization in bedrock or oxidized mineralization in mines? The reader must guess the source of lead and zinc. In the absence of aquifer characteristics or water chemistry for unaffected wells upgradient of the site, a reader could infer that since none of the ground water samples contained elevated cadmium, zinc or lead, the low concentrations in ground water samples stem from natural bedrock sources.

The focus of the public health assessment is to identify how people are exposed to chemicals in environmental media that can cause health problems. We provide public health observations for EPA and communities; we do not identify source areas.

c. The statement, "Results of the analysis showed that no wells contained detectable levels of volatiles, semi-volatiles, or pesticides" is misleading, as only two of 42 wells were sampled for the constituents listed.

We have revised the document to indicate that only 2 out of 42 wells were sampled and were not contaminated by volatiles, semi-volatiles, and pesticides.

d. "In the most recent sampling of the site by EPA, 12 residential wells were sampled." No reference is made to this study in the Site Description and History section page 7, which lists the other site investigations. The most recent EPA reference in the bibliography is 1991. When were these important samples collected and why were these data not included in this report?

This most recent sampling information has been added to the *Site Description and History* section and the Private Well section under *Off-Site Contamination* and referenced.

13. page 22, para 1, Surface Water: The sentences, "The levels for total lead had increased for all water levels. The total lead concentration of 680 ppb under high flow conditions was the highest during the investigation," are confusing. The report mentions that samples were taken 5 miles downstream from the site, 16 miles upstream from the site (background), and 37 miles downstream from the site. Are these sentences meant to report that lead levels increased farther downstream or that they increased at the sampling location 5 miles downstream of the site? Clarify this paragraph. Since an upgradient (background) station was sampled, the downstream results should be compared to it. Increased metal concentrations alone do not equate to environmental degradation. Were Missouri Water Quality Standards (10 CSR 20-7) exceeded for the short reach downstream of the tailings pile? Provide a comparison to Missouri aquatic life criteria. the comparison to concentrations at Brown's Ford 60 miles downstream is irrelevant due to the likely presence of other metal sources over this long reach.

The paragraph has been clarified to better illustrate the increases in detected metals below the Big River tailings pile. The comparison to Brown's Ford indicates that the influence of the tailings piles has decreased as distance downstream from the source of contamination (tailings piles) increases. No reference was made to Missouri Water Quality Standards, but we have added them to Table 5.

14. page 22, para 5 (last): Refer to the 1962/1963 and 1977 water quality studies. Four, not two, water quality studies appear to have been reviewed for this report.

The document has been revised for clarification that only two studies were done.

15. page 22, Surface Water: Surface water results should be compared to Ambient Water Quality Criteria (AWQC) for the protection of aquatic life. EPA reports chronic AWQC of 1.8, 74, and 180 μg/L for cadmium, lead and zinc, respectively, at a hardness of 50 mg CaCo3. A comparison of AWQC to surface water levels reported in Table 5 shows that measured levels of lead in dissolved water, the fraction that is available for uptake by biota, do not exceed AWQC at any sampling location. Measured levels of cadmium in the dissolved fraction and zinc exceed AWQC only at the Desloge station.

We have added the Missouri Water Quality Standards (MDNR 1992) for the protection of Aquatic Life to Table 5; however, those water quality standards do not represent any values that can be used to evaluate human health issues. For that reason, they are not necessary to use in our evaluation, but people may have an interest in them.

16. page 25, Indoor Dust para: The statement that "since houses near the site are about 20 to 30 years old indicates that individuals may have been exposed to contaminated indoor dust for that period" is misleading. It implies that the same individual(s) have lived in those houses within a mile of the site ever since the house was built. Exposure duration's should be based on the length of time spent at one residence, not on the structure.

The statement following the sentence you quote, says the "people could have been exposed." The people who reside in the area know how long they have been there. We offer the possibity that at least some of the people have been there 30 years.

17. page 28, Groundwater Pathways:

    a. A paragraph on site geology early in the report would aid in understanding the previous 28 pages. The simplistic scenario provided in the first paragraph does not convince the reader that relatively immobile lead ions leach from the tailings through limestone to groundwater, especially since lead concentrations in distant private and residential well samples are apparently equal to or greater than that recorded for the landfill office well. Zinc, present in the tailings and soil at elevated concentrations, is much more mobile in solution than lead and typically occurs at elevated concentrations in leachate samples at this and other lead-zinc mining sites (see Table 2). However, the zinc concentrations in the landfill office well sample are very low (140 μg/L), probably at background levels.

The document has been revised.

    b. The last sentence of the first paragraph states that the landfill office well water is "contaminated" based on one sample that exceeds the Action Level for lead (concentration of lead in that one sample equals 17 μg/L lead vs. EPA action Level of 15 μg/L). Exceedance of the lead action level does not, in itself, indicate lead contamination. Rather, in cases where lead levels exceed the Action Level, EPA promulgated a zero MCLG and a treatment technique. The treatment technique includes a 15 μg/L action level at the tap (57 Federal Register, 60886). Re-sampling is advised to determine the source of lead (plumbing, formation water, etc.). The EPA has not yet reached consensus on an appropriate health-based numeric criteria and accordingly has not promulgated human health criteria for lead in drinking water.

The well has been resampled and still contains lead above the EPA Action Level of 15 ppb. We consider the presence of lead in drinking water above the Action Level as contamination.

    c. Without performing a statistical analysis or without data characterizing upgradient water chemistry, it cannot be determined that on-site groundwater contains any more lead or zinc than off-site groundwater. Therefore, the reference to an "off-site groundwater pathway" causing regional water quality problems is premature.

We have modified this statement.

    d. For the municipal water supply, only lead is mentioned as being detected. This conflicts with an earlier statement on page 20 that says that other metals were detected in the 1991 sample of the Flat River Public Water System. Zinc occurs in detectable quantities in most groundwater samples in this area. Provide the metals data in a revised Table 2 (drinking water only) so that the reader can draw a conclusion regarding the reported metal concentrations in the public supply.

Other metals may have been detected but were below comparison values. We have revised the statement on page 20 for clarification. Table 2 lists the contaminants found in on-site groundwater and has nothing to do with the public water system. Analysis of the water from the public water system is available to anyone wanting a copy from the public water supplier.

    e. In review, the exposure pathway to zinc and lead in groundwater is complete because area residents use ground water for drinking. The attempt in this section to isolate on-site exposure versus off-site exposure is weak and unsupported and should be deleted and replaced by a description of the complete exposure pathway only. Exposure to other metals in municipal or private drinking water (arsenic, cadmium, cobalt, and nickel) appears to have been neglected in this assessment because they were not detected, although no data are presented in the report to support this.

A completed exposure pathway exists. Lead and zinc are in some off-site wells and the on-site landfill well at levels above comparison values. When metals (e.g., arsenic, cadmium, cobalt, and nickel) are not present above comparison values, we do not expect adverse health effects to occur even if people are exposed to the chemicals.

18. page 29, Fish Pathways: "The number of people who are catching and eating the contaminated fish is not known." Considering that the proportion of resident and nonresident diet that consists of contaminated bottom feeders is unknown, then the human health risk associated with this specific pathway is unknown and should be stated as such. The quantification of risk via ingestion of site fish is not difficult but would require either site-specific exposure frequency information (as recommended in RAGS, Exhibit 6-17) or the use of the default factor of 48 days/year per capita (RAGS, 1989). The report does not make recommendations for future surveys to answer the exposure frequency question.

Your comment about the human health risk associated with this particular pathway was good and the document has been revised to reflect that information. To determine the actual health effect of this pathway a study would need to be done to determine the actual difference of lead levels between fish- and non-fish eaters. Or, as a second choice, a risk assessment could be completed. Little is known about the additional effects consuming lead-contaminated fish has on those already exposed through different pathways. With the fish advisory in effect, people are aware of this pathway and hopefully will avoid it.

19. page 29-30, Toxicological Evaluation: It is well established that zinc, cadmium, lead and arsenic in the form associated with mine tailings is very poorly absorbed through the skin. This alluded to in the lead and groundwater discussion on page 31, but should also be specified for the other metals. When exposure occurs, individual characteristics such as age, sex, nutritional status, health status, lifestyle, and genetics influence how the chemical is absorbed, distributed, metabolized, and excreted. ATSDR minimum risk levels (MRL) are not appropriate for childhood exposure to cadmium. Cadmium is a long-term chronic toxin to adults but not to children. The literature on cadmium toxicity is clear that the calculated reference doses and other threshold criteria are based on lifetime (or at a minimum) a thirty-year exposure (Nogawa, 1989). Children are not the appropriate target for these type of calculations for cadmium.

We agree that the metals found at the site and in the area are poorly absorbed through the skin and have removed references to a completed dermal pathway. We have also included an explanation under Completed Exposure Pathways that dermal exposure is not a problem. Regarding your discussion of MRLs and cadmium, the pages you mention include only a general discussion of different methods ATSDR has of determining a screening level that should be a "safe" level.

20. page 32-33, Lead: The information regarding the toxicity of lead presented in this document is general and is not clearly attributable to different types of exposures. For example, it is unusual to find some of the mentioned neurologic effects (i.e., foot drop and wrist drop) other than in severe (high) occupational exposures. This section should more clearly show under what conditions these symptoms have been reported since many are relics of historic past and occupational settings that are no longer common or exist in this country. There is also a statement that says, "Few studies are available that indicate how much lead in dust and soils would result in an increase of blood/lead levels when lead is ingested or inhaled." This is incorrect. There have been numerous studies performed in the United States that have looked at the relationship between mine waste material and blood-lead levels (Steele, 1990, Johnson, 1991). Due to the significantly reduced bioavailability of mine waste materials, it is not appropriate to assume that the presence of mine waste materials automatically results in elevated lead levels in potential receptors. The mini-blood lead study conducted at this site demonstrated that local lead levels were not significantly elevated.

We do attempt to evaluate site-specific situations when evaluating the toxicological implications that

exposure may have on the people in a community. Because we do not yet know what subtle health effects may occur at specific blood-lead levels, lead discussions tend to be more general in nature. We agree that the mine waste at this site may have less bioavailability than other sources (paint, smelting), but the mini- blood-lead study is a starting point in determining the effect the tailings have on the community. An exposure study is underway to determine the effects on children that are most likely to be exposed and who are expected to suffer the greatest effects.

21. page 32, para 1: The document states that residential lead soils in the range of 400-500 ppm are not considered harmful to children. The next sentence says that lead was found on-site at a maximum of 13,000 ppm and comes to the conclusion that this high lead level is typical of measured on-site soil levels and that therefore, a major public health problem is present. This seems to be a conclusionary statement not supported by the facts presented.

We have modified this statement.

22. page 32, para last: The reference cited for the effects of lead exposures on IQ is dated and should be updated to reflect more recent, post-1990 data.

We agree and have revised the document.

23. page 33, para 1: It should be emphasized that lead has not been shown to be a carcinogen in humans. The B2 designation is based on animal studies.

We have revised the document.

24. page 33, para 2: Reference to pica behavior should be caveated to indicate that pica is not a common condition and that it is a medical condition that is not amenable to treatment by soil remediation. Comments concerning organic forms of lead should be deleted since the potential contaminants of concern are all in inorganic compounds.

The sentence on pica children is an identification of the population at greatest risk from exposure--pica children. Although pica is considered a rare medical condition, young children, especially crawling-aged children, exhibit a greater hand-to-mouth behavior than older children. On organic forms of lead, the statement is saying that exposure to organic forms of lead in the occupational setting may be in addition to exposure to inorganic lead at the site, causing extra exposure to and increased levels in the body.

25. page 33, para last, Cadmium: The target population for cadmium is not children but rather adult residents due to long-term chronic exposure. The statement, "Inhalation of low levels of cadmium over 70 years could lead to similar problems," referring to calcium bone loss and fractures is unsubstantiated at the "proposed" dose levels potentially ascribed to the site.

The statement reads "several years," not "70 years."

26. page 34, para top, Cadmium: EPA has classified cadmium as a B1 carcinogen for inhalation only. Ingestion of cadmium had not been shown to cause carcinogenic effects.

We agree and have revised the document.

27. page 34, para 2, Cadmium: The use of a 70-year exposure duration (the term exposure frequency is incorrectly used here) is inappropriate. EPA has determined that the upper-bound (90th percentile) length of time spent at one residence is 30 years. Also, the equation presented to estimate risks (unit risk times air concentration times exposure duration) seems to be incorrect, as the result has the units of years, which are not indicative of risk. In fact, the "16 cases per million" result was correctly calculated

by multiplying the unit risk value by the air concentration only. Therefore, the reference to the exposure duration is not needed.

We agree and have revised the document.

28. page 34, para 4, Arsenic: Further information is required on naturally occurring background levels of arsenic. The third paragraph in the arsenic section says, "Inhalation of low levels of arsenic is believed to increase lung cancer." Arsenic lung cancer studies are based on occupational exposures at high concentration and duration. (ATSDR, Toxicological Profile). Otherwise, general environmental airborne arsenic impacts have typically been associated with active smelting activities as opposed to tailings piles.

We have expanded this paragraph.

29. page 35, para 2, Arsenic: See comment 27.

We agree and have modified this paragraph.

30. page 35, Zinc: It should be emphasized that zinc is an essential element. This section needs to be updated to demonstrate the reported changes in normal dietary intake levels. It should be stated in this section that it is highly uncommon in the literature to find (if found at all) episodes of zinc overdoses attributable to environmental causes. Most reports of zinc intoxication in the United States are secondary to vitamin supplements. (ATSDR, Toxicological Profile).

We agree and have expanded this paragraph.

31. page 36, para 1: This section states that lung cancer rates are highly dependent or confounded by smoking rates. Therefore, it is impossible to draw conclusions regarding "underground miner" without knowing relevant behavioral data.

We are only reporting results of a study, not endorsing it.

32. page 37, para 2: Of the 16 employees and residents whose blood lead levels were measured, only two individuals had blood lead levels higher than 5 μg/dL (levels = 10 and 12 μg/dL). The current EPA recommendation through the Centers for Disease Control and Prevention is a target for children of 10 μg/dL with a 5 percent Exceedance. The document does not indicate whether the individuals tested were children or adults. Being an employee of St. Joe State Park implies that at least some of the individuals tested were adults. It is also noted that there may be other factors influencing the blood lead levels that were over 5 μg/dL that are not site related. It is significant, however, that when actual biological sampling was done, very low blood leads were found. This implies that the actual dose received by potential receptors appears to be low. Nowhere in the document is a discussion of the bioavailability of mine waste mentioned. It has been clearly demonstrated in the literature that the bioavailability of the individual metals (including lead) affects the toxicity of the mineral material.

We agree and will amend this paragraph. The document will indicate whether the individuals tested were children or adults.

Blood lead measurement indicates recent exposure (past 6 to 8 weeks). Attempting to address past exposure with a blood lead determination would not be appropriate. Past exposures to lead would better be addressed by using other techniques (x-ray, bone tissue biopsy, etc.). Finding low blood-lead levels does not exclude past exposure.

Since past exposure of workers at the site is not known, investigation of past occupational history is important. In the event that past exposure existed, it can be assumed that lead may be stored in the

bones of the body, and that it can be mobilized to the blood. In this case, effects associated with blood-lead levels may be expected.

It is also important to consider that lead dust can be carried home from an occupational setting and "could easily cause low level lead accumulation in the spouse's body" which is widely known to present prenatal risk to child development (Ashford NA, 1987) .

In regard to the bioavailability of lead compounds in the mine tailings, we agree that this is a question that continues to be researched. We hope that the current ATSDR-funded lead exposure study in the area may provide some additional answers to add to the on-going scientific discussion about the bioavailability of lead compounds.

33. page 38, Conclusion 1: The elevated rates of lung cancer are initially attributed to excessive smoking (DOH 1985-86) then in the same conclusion, it is stated that it is not known if there is an association between smoking, carcinogens in ambient air, and lung cancer rates. If the results of the 1985-86 study were flawed or inconclusive, state this. Otherwise, if smoking was determined to be the cause in the initial study, why are other airborne carcinogens now being considered?

We have modified this paragraph.

34. page 38, Conclusion 2:

  a. "Total lead has been found in residential soils at levels above what would be safe for a child's exposure." As written, this assessment offers no support for this statement. No reference level is listed for lead (page 18) nor are other regulatory criteria for lead (for other sites) identified.

We have revised the statement, and there is no listed safe level or comparison value for lead because one is not known at this time.

  b. The statement that observed arsenic concentrations are above ATSDR's reference levels could probably be made for any soil type in the region. ATSDR's conservative CREG (pica child) of 0.4 ppm for arsenic is well below the average arsenic concentration in Missouri agricultural soils. The geometric mean of 1140 samples is 8.7 ppm (U.S. Geological Survey, 1984) and the reported background arsenic levels in soils from the 1990 LSI study is 6.2-9.5 ppm.

The CREG is an environmental screening value to determine what chemicals should be further evaluated for public health implications. They are not used to imply any public health condition.

35. page 38, Conclusion 3: The conclusion that the metals in concentrated dust samples from homes is related to the presence of the tailings piles is not supported. No scientific evidence is provided in the report to indicate that tailing material (or tailings dust) is present in the vacuum samples. Table 4, by its comparison of reference values, implies that all metal content above the comparison value is attributable to tailings, but the text offers no firm evidence to show that the reported levels are higher than in homes distant from the site.

We have modified the conclusion.

36. page 38, Conclusion 4: Lead levels in fish do not have to be elevated to: "contribute to the daily intake." Any lead in fish or other food items, drinking water, etc., could contribute to the daily intake. Please clarify this statement.

That is exactly the point we are trying to get across. When you have elevated levels of lead in fish, soil, tailings, food, and water, the higher the lead level, the more the contribution to the daily intake. We have clarified the statement to include other items.

37. page 38, Conclusion 5: Clarify that the EPA Action Level applies to tap samples.

We have revised the conclusion and the document to state that the EPA Action Level for lead is for public drinking water systems at the tap.

38. page 39, Recommendation 1: The first recommendation calls for "actual air exposure levels" when data on arsenic and cadmium concentrations in air are currently available from the 1990 LSI study. Is this recommendation meant to imply that the 1990 data are insufficient to meet the goals of the study. If not, state the reason and what new methodology should be used in a proposed future sampling effort.

We have modified the recommendation, but the air levels listed in the 1990 LSI were for a short-term, low-wind condition. That sampling is not representative of conditions that may exist over a long period of time. A long-term ambient air monitoring program, that includes the known contaminants present, would be a much better indicator of actual exposure levels to anyone exposed to the dust.

39. page 39, Recommendation 2: A postulated exposure pathway is offered here, but no risk assessment is made in the document that would convince the decision maker that there was indeed a health risk. In fact, blood-lead sampling of workers on tailings suggests that the likelihood of elevated blood-leads attributable to tailings exposure may be low.

We have modified the recommendation somewhat, but as mentioned before, the document is not intended to assess risk for EPA decision makers. We would have to know what study, in particular, you are referencing before we could comment on the worker study.

40. page 39, Recommendation 3: Confirmation of earlier (vacuum bag) results is not needed. If re-sampling is deemed necessary, conventional swipe dust sampling of on-site and background locations is recommended so that results can be compared to samples collected from homes at other mining sites.

Indoor dust sampling is necessary in order to determine the amount of contaminants, to estimate an exposure dose, and to evaluate possible health effects. The recommendation has been modified for clarity. As mentioned before, a child blood-lead exposure study is planned and will include the sampling items you mention.

41. page 39, Recommendation 4: A simple survey of fishermen could be conducted to estimate local consumption of suckers caught from the Big River.

A survey of fishermen would very likely provide some helpful information, but would do little to eliminate exposure.

42. page 39, Recommendation 5: Water softeners have been shown to be effective at reducing lead concentrations at the tap to acceptable levels.

Water softeners are an alternative to lowering lead levels in drinking water but should not be considered the only approach.

43. Table 4: Presents a summary of the indoor dust (vacuum) sample results. There are no health criteria directly applicable to metal concentration in dust in homes and typically the results would be compared to a background data generated by sampling homes distant and upwind of the site. After a statistical analysis comparing mean off-site (upwind) values to on-site values, it could be determined if metals levels in indoor dust were attributable to releases from the tailings piles or to naturally-occurring metals levels. In lieu of suitable background data, Table 4 includes for reference ATSDR's soil comparison values. The use of health-based criteria derived for exposure to surface soils, which are based on incidental ingestion of soils, as a means of evaluating potential risks associated with inhaling or incidentally ingesting indoor dust is inappropriate. Further, ATSDR reference values for ambient air

are also listed in Table 4, with an explanation that no air measurements were taken in or around residences. Without air data, no logical comparison with air criteria can be made and the inclusion of reference values for air in Table 4 is not meaningful.

The values were included because much of what was in the vacuum cleaners had been on floors and in home air at one time, and babies eat a great deal of dirt from floors. We agree, though, that dust and soil levels are not directly comparable, so the comparisons values for soil have been removed to avoid any confusion by the public. The comparison value for air has also been removed.

44. Table 9:

a. This table presents the results for lead and cadmium in biota tissue. Tabulated results for zinc and copper are not presented although the text on page 6 states that "in 1982,...the US F&WS found elevated residues of lead, cadmium, and zinc in every biological form examined,...." Also, page 29 indicates that elevated levels of copper were found in mussels. Amend Table 9 to include other metal results for comparison.

Lead and cadmium levels were provided from the 1982 US F&WS study to demonstrate that biota in the Big River is being contaminated by the different tailings piles for many miles down stream. Only lead and cadmium are listed because they are the contaminants present at levels of concern and were listed in summary table form to facilitate understanding from the reader's perspective.

b. EPA has established screening values (SVs) which are described in their Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories (EPA, 1993). SVs are "concentrations of target analyses in fish or shellfish tissue that are of potential public health concern and that are used as standards against which levels of contamination in similar tissue collected from the ambient environment can be compared. Exceeding these SVs should be taken as an indication that more intensive site-specific monitoring and/or evaluation of human health risk should be conducted." The SV for cadmium is 0.01 mg/kg. Assuming the results presented in Table 9 are of edible tissue only, the red-horse and catfish appreciably exceed the SV at Washington State Park only. Furthermore, exceeding the SVs should only prompt additional investigations into the actual frequency these fish are ingested by humans. Although SVs have not been identified for lead, the same investigative philosophy should apply. Table 9 would benefit from the addition of SVs as comparative values, as was done in Tables 2, 3, and 4.

Although SVs were not used in this case, background values are provided for biota collected 16 miles upstream (Irondale). Further downstream, values observed increased, showing higher accumulations in samples collected in biota up to 60 miles downstream from the site. Runoff from the different piles may contribute substantially to this effect. We feel that the fish advisory, which is intended to stop exposure from this source of contamination, is more important than an investigation of consumption practices at this time; however, such an investigation would be interesting.

45. Table 10: Consider deleting the dermal absorption as complete exposure route, since most metals are not readily absorbed through the skin.

Although there is a completed exposure pathway by dermal contact, we agree that the metals present are not readily absorbed through the skin and should not add to exposure. We have removed dermal contact as a significant route of exposure from Table 10 and from the text.

1. [1]Note: The 15 ppb Action Level was developed for use with public water supplies and is not applicable to a single sample collected from a private well. ATSDR does use this value as a comparison value when selecting a contaminant for further evaluation if exposure to lead is occurring.

Figure 1

Big River Mine Tailings/St. Joe Minerals
Area Map

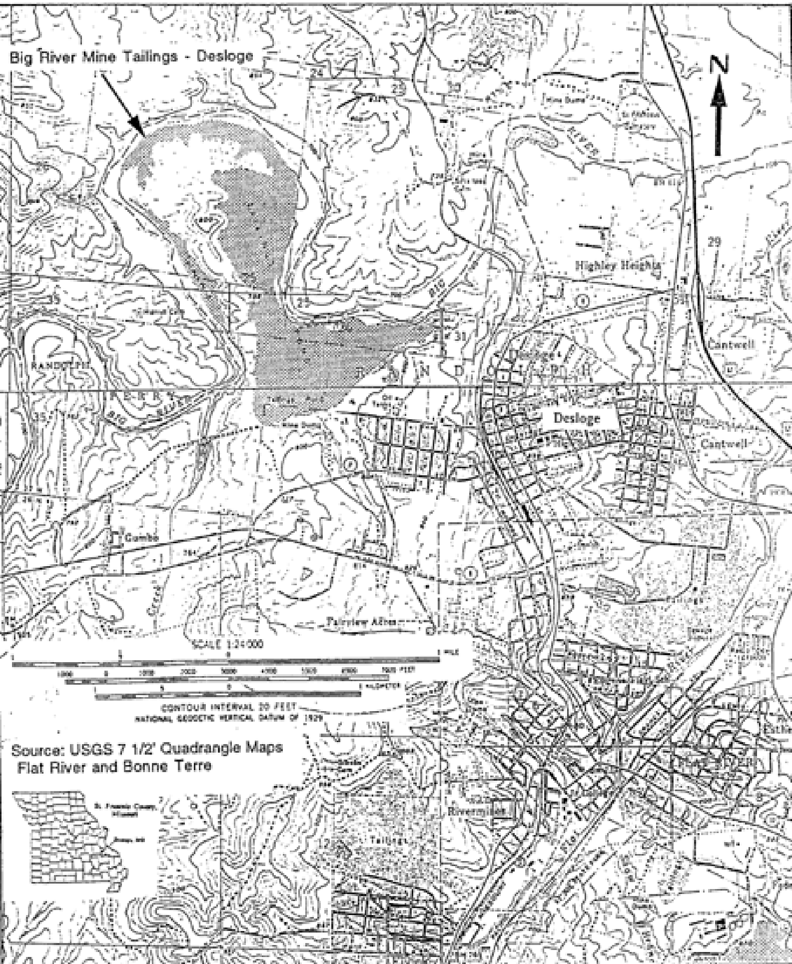

Figure 2

Big River Mine Tailings/St. Joe Minerals Site & Other Major Tailings Piles